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THE

PHILOSOPHICAL MAGAZINE.

NUMBER XIV.

JULY 1799.

ILLUSTRATED WITH

THE FOLLOWING ENGRAVINGS BY MR. LOWRY.

1. A 4to Plate relative to the Structure of the Cryſtals of Oxyde of Tin.

A Plate illuſtrating the beſt Conſtruction of the Vanes of Windmills, ſo far as concerns the Angle of Weather.

LONDON:

PRINTED FOR A. TILLOCH:

And ſold by Meſſrs. RICHARDSON, Cornhill; CADELL and DAVIES, Strand; DEBRETT, Piccadilly; SYMONDS, Paternoſter-row; MURRAY and HIGHLEY, No. 32, Fleet-ſtreet; BELL, No. 148, Oxford-ſtreet; VERNOR and HOOD, Poultry; HARDING, No. 36, St. James's-ſtreet; WESTLEY, No. 159, Strand; J. REMNANT, High-ſtreet, Bloomſbury; W. GILBERT and ARCHER, Dublin; and W. REMNANT, Hamburgh.

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Number XIII. is illuftrated with a Plate of Figures to explain Volta's Theory of Galvanifm—Apparatus employed by Dr. Van Marum for the Combuftion of Phofphorus in Oxygen Gas.

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THE PHILOSOPHICAL MAGAZINE.

NUMBER XV.

AUGUST 1799.

ILLUSTRATED WITH

THE FOLLOWING ENGRAVINGS BY MR. LOWRY.

1. Mr. MUSHET's Pyrometer for ascertaining the Heat of an Assay-furnace.
2. VON HAUCH's New Discharging Electrometer, laid before the Royal Society of Copenhagen. And,
3. HUMBOLT's Portable Barometer for Travellers, &c.

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NUMBER XVI.

SEPTEMBER 1799.

ILLUSTRATED WITH

THE FOLLOWING ENGRAVINGS BY MR. LOWRY.

1. A Plate to illustrate the comparative Height of the Mountains of Venus, the Earth, and the Moon; according to the Observations of M. SCHROETER of Lilienthal.
2. C. REGNIER's New Powder-proof for ascertaining the comparative Strength of Gunpowder. And a microscopic representation of certain Animalculæ found on the Surface of a Fish-pond in Norway, which gave it a Red Appearance.

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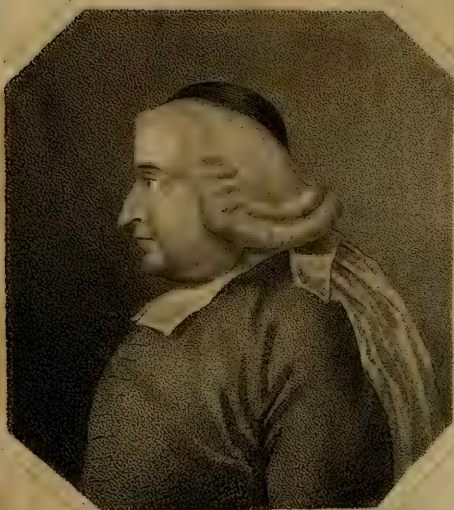

Mackenzie sc.

Roger Joseph Boscovich

THE PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY.

"Nec aranearum ſane textus ideo melior, quia ex ſe fila gignunt. Nec noſter vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

VOL. IV.

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OF THE

FOURTH VOLUME.

On

THE

PHILOSOPHICAL MAGAZINE.

JUNE 1799.

I. *On the Poſſibility of Caſual Mutilations in the Bodies of Animals becoming in the Courſe of Time hereditary Marks of Diſtinction. By Profeſſor* BLUMENBACH *.

THAT it is poſſible for mutilations produced in the bodies of animals, either by accident or by artificial means, eſpecially when repeated through a whole ſeries of generations, to degenerate in the courſe of time into hereditary marks of diſtinction, ſeems *à priori* to be incontrovertible. At any rate, I ſhould be glad to ſee the phyſiologiſt who can aſſign a reaſon why this ſhould not be as poſſible as the tranſmiſſion of hereditary organic diſeaſes, or hereditary monſtroſities †, or

* From *Magazin fur das Neueſte aus der Phyſik.* Vol. VI.

† Of the numerous and partly well known inſtances of this kind I ſhall quote only a recent one, mentioned by M. Schulz in his *Obſervations on a monſtrous canary bird*, p. 17. "A Spaniſh bitch," ſays he, "which had been in my poſſeſſion for ſeveral years, was not only brought forth without a tail, but at various times produced puppies ſome of whom were deſtitute of tails alſo. As often as this bitch brought forth more than one puppy, one of them perhaps was quite perfect; the greater part, however, had half tails or tails ſtill ſhorter, and one at leaſt had no tail at all. The moſt ſingular thing was, that the young almoſt always had a reſemblance to

or the most individual traits in family likenesses, such as a thick under lip, strong eye-brows, and so on, which certainly did not all descend from Adam; but which have first appeared at a certain generation, and since that period have been continued, with more or less constancy, by hereditary transmission.

I. *Instances among Animals.*

We are told by Sir Kenelm Digby*, that the tail of a cat having been cut off when young, some of the kittens, which she afterwards brought forth, were always without tails. Nath. Highmore †, who in explaining the nature of generation differs so much from Sir Kenelm, says that he saw a bitch which wanted almost the whole tail from the rump, and that the half of her young were brought into the world with tails, and the other half without. Buffon ‡ asserts that he saw dogs, the ears and tails of which had been cropped for many generations, and which transferred this mutilation, either totally or in part, to their posterity.

M. R. Masch, of New Strelitz, gives an account, in the *Naturforscher* §, of a butcher's dog, the tail of which, according to custom, had been cut off, and which having copulated with a she-wolf, that had been caught, the latter produced three bastards. Among these was a male, half grey like the father, and born with a cropped tail; so that the casual mutilation of the dog, as the author says, was transferred to this bastard.

We are told by D. Forster ‖, that it has been remarked in

to the father, whether grey-hound, spaniel, &c. in regard to colour and bodily conformation; and derived nothing more from their mother, the Spanish bitch, than the singularity of having only the third part of a tail, or no tail at all."

* On the Nature of Bodies, p. 214.

† History of Generation, p. 31.

‡ Histoire Naturelle, vol. xiv.

§ Part xv.

‖ Beyträge zur Volker-und Lander-Kunde, Part 1.

England,

England, that when horses are continually docked, and both stallions and mares kept so for many generations, the foals, at last, come into the world with some articulations fewer in the tail. Buffon * has enlarged pretty fully on this subject, and endeavoured to prove, by the help of anatomy, that the callosities on the breast-bone and knees of the camel are merely the consequence of their subjection, and the force by which these animals of burden, as is well known, are obliged to kneel down; and as the young camels, when brought forth, have callosities of the like kind, he gives this as a proof of the hereditary transmission of such variations produced by art.

II. *Instances among the Human Species.*

Cardan † speaks of the well known ancient custom of the Peruvians of *Puerto Viego*, who pressed between boards the heads of their new-born children. This custom, however, became afterwards like a second nature; so that, in the course of time, children were brought into the world with heads formed in that singular manner: and Cardan expressly says, that this flatness of the head was originally the work of art, and not of nature. *Constat igitur*, to use his own expressions, *humanam formam multis modis variari, tum arte, tum diuturna successione.* Hippocrates, in his work upon air, water and climate, mentions something of the like kind in regard to the *Macrocephali*, a people on the borders of the Black Sea, who pressed the heads of their new-born children; and this practice repeated, through many generations, produced at length an hereditary distinction; so that the children were born with heads of a particular form. "At first," says he ‡, "the practice of the country seems to have been the cause of this conformation; but custom afterwards be-

* Histoire Naturelle, vol. xi.

† Vol. iii. p. 162 of Spon's edition of his works.

‡ This passage is translated from the original in Chartieri's edition, vol. vi. p. 206.

came nature. Thofe who had the largeft heads were confidered as the nobleft; and for this reafon the *Macrocephali* preffed the yet pliable tender heads of their children with their hands, and forced them to extend in length by bandages and other means. This artificial procefs gave occafion to the fubfequent increafe of fize in the head among thefe people, fo that artificial means were no longer requifite for that purpofe." Hippocrates, however, adds in a fhort fection: "That in his time their heads had no longer that fingular form completely, becaufe they had entirely neglected the above artificial means of formation." But that this very little contradicts his preceding account and opinion is fhewn by the intermediate paffages, where he endeavours to explain the phenomenon from his well known theory of generation. "The generative matter," fays he, "is collected from all parts of the body. From found bodies it comes found, and from difeafed bodies difeafed. Now, as bald heads, blue eyes, and overgrown bodies are tranfmitted in families, and the like rule takes place in other circumftances of conformation, why fhould not children with great heads be produced by great headed parents?" Hippocrates, therefore, evidently meant only that in the courfe of time Nature fometimes abandons forms fhe has affumed, and returns again to the original.

Ariftotle, in his work on the generation of animals, fpeaking of the grounds on which the theory of Hippocrates refpecting generation is founded, fays: "It is very probable for this reafon, befides others, that children not only refemble their parents in internal and innate properties, but even in external marks which are merely cafual; for there are inftances of moles being tranfmitted from parents to their children, and on the very fame parts of the body. He himfelf quotes a Chaldean, who, having a mole on his arm, tranfmitted it to his fon, though in the latter it was not fo apparent as in the father. Pliny alfo, where he treats of marks, moles, and the like, being fometimes inherited by children,
adds,

adds, by way of example: *Quarto partu Dacorum originis nota in brachio redditur.* In my opinion, this paſſage alludes to the hereditary tranſmiſſion of moles among the Dacians, Illyrians, &c. who, according to the teſtimony of many of the Ancients, were diſtinguiſhed by this ſingularity.

The late M. Oſann once came to me, full of aſtoniſhment, and told me that he had met with a ſimilar inſtance in the family of a ſtaff-officer, who lived in the neighbourhood. The father in his younger days had received a wound in the little finger of his right hand, which had been rendered crooked during the cure; and his ſon and daughter were born each with the little finger of the ſame hand crooked. I have ſince ſeen both the father and daughter, and have been convinced, by inſpecting their hands, of the truth of the above information.

A literary man of very great acuteneſs, when converſing with me on this ſubject, ſtarted the following objection: "If artificial mutilations can become hereditary, children born of circumciſed parents muſt often be born without the foreſkin, which does not appear to be the caſe." At that time I was acquainted with only one inſtance of this kind in Steph. Gerlach's Journal; but one example did not appear to me to be of any peculiar weight. I, however, once happened to aſk a Jew of this place, a man not deſtitute of learning, and well acquainted with the ritual of his nation reſpecting this circumſtance, and was told that it frequently happened that the children of the Jews were brought into the world with ſo ſhort a foreſkin that it required an experienced and careful hand to circumciſe them. This innate deficiency is diſtinguiſhed by a particular Hebrew appellation, *nauld mohl*, or born circumciſed. His own father, who had circumciſed above 700 boys, and who was celebrated on account of his expertneſs in this caſe, not at all uncommon, often ſpoke of the difficulty of performing the operation under ſuch circumſtances. In a word, what had appeared to me an argument againſt the hereditary tranſmiſ-

ſion of artificial mutilations, became unexpectedly an important argument in its favour. I will, however, readily acknowledge, that all the caſes above mentioned may not be of equal authenticity, and equally incontrovertible; but even though the leaſt improbable ſhould be rejected, there will ſtill remain, to ſupport the probability of the thing, as many as could be deſired for a propoſition which cannot well be proved by direct experiments made for the purpoſe.

II. *Report on the Travels of* C. OLIVIER *and* C. BRUGUIERE, *undertaken by order of the French Government, through the Ottoman Empire, Egypt and Perſia, during the Years* 1792, 93, 94, 95, 96 *and* 97*.

[Concluded from the laſt Volume, p. 347.]

THIS journey was extremely intereſting; for, beſides the great number of objects which we collected, and the obſervations we had occaſion to make, we were ſurpriſed to ſee a country exceedingly fertile, yet almoſt a deſert, and often volcanic, exhibiting, at every ſtep, veſtiges of ancient cities. We croſſed the Euphrates and the Tigris on wretched wooden boats; and two rivers, which flow from the mountains of Curdiſtan, on boats formed of a number of inflated ſkins joined together. I ſhall deſcribe, with ſome minuteneſs, this ſimple method of croſſing rivers, becauſe it might be employed with advantage in Europe, on account of the facility and trifling expence of tranſporting a great number of ſkins; of inflating them in a moment, and uniting them firmly together by means of the branches of trees; and of conveying, in this manner, over the largeſt rivers, a whole army without any danger.

When we arrived at Bagdad, the pacha was ſo ill that two Perſian phyſicians, who attended him, had given over all hopes

* Read in the Sitting of the National Inſtitute, February 14th. By C. Olivier.

hopes of his recovery. His aftrologer had read in the ftars the fatal fentence; the kiaya pacha and fome of the grandees were already forming intrigues to fucceed him, and the janiffaries were taking up arms to fell their fervices to the higheft bidder. The Arabs of the defert, and of Mefopotamia, waited only for the moment of his death to plunder the caravans and rob travellers. This city was threatened with a general infurrection. Commerce was fufpended; and it was impoffible for us to continue our journey. The pacha begged us to give him our advice, until we fhould have an opportunity of fetting out for Perfia. We thought ourfelves bound to comply with his requeft, and had the fatisfaction to reftore him to health in the courfe of a few days. From that moment order was every where re-eftablifhed; and the kiaya alone paid, with his head, for the fteps he had taken to affume the place of his benefactor. The pacha fhewed us every mark of gratitude, made us a prefent of two fine Arabian horfes, and gave us letters of recommendation to the khan of Kermancha, and the minifters of the king of Perfia.

We did not delay a moment to provide ourfelves with Perfian dreffes, and whatever elfe was neceffary; and departed on the 16th of May 1796, with the regret of leaving behind us a box containing feveral very valuable jewels, deftined as prefents to the Perfian court, which the envoy of the republic at Conftantinople was to have fent after us.

The ufual heat at Bagdad, during fome hours of the day, is from 110° to 113° Fahr. On the day of our departure the thermometer was already at $99\frac{1}{2}$° Fahr. We had here an opportunity of feeing a phenomenon which explains the origin and caufe of that fingular and tranfitory wind which deftroys men and animals, if proper precautions are not taken to guard againft its effects.

On our arrival at Kermancha, the firft city of Perfia, we waited on the khan, made him acquainted with the object of our travels, and delivered to him the letter from the

pacha of Bagdad. The khan aſked us many queſtions reſpecting the different ſtates of Europe, with which he ſeemed to be little acquainted, and reſpecting our manners and cuſtoms. He dwelt moſt on the countries of the Ottoman empire which we had traverſed, and particularly Bagdad, becauſe in that city the aſhes of Ali are preſerved. He gave orders to one of his officers to accompany us to court, and procured us the neceſſary paſſports. On the 1ſt of June we arrived at Teheran, where we learned that the king and his miniſters had ſet out in the beginning of ſpring on an expedition, the object of which was ſuppoſed to be the conqueſt of all Chorazan.

I was highly pleaſed with the idea of undertaking this journey, and I conſidered it as a fortunate circumſtance that the king was at the head of an army in one of the moſt intereſting provinces of Perſia; into which no European traveller had penetrated, and which produces the moſt remarkable plants, as well as the greater part of the drugs brought to us from the Eaſtern countries; but C. Bruguiere had been ill for a long time, and was threatened with a dyſentery. The dragoman himſelf was indiſpoſed, and reaſons were not wanting to diſſuade me from undertaking the journey. "It is not poſitively known," ſaid ſome, "where the king is; and it is dangerous to approach the army in this country, becauſe people are plundered, and even killed, before they can be known and protected. It will require more than a month to reach Chorazan, and the king muſt return in two." Theſe reaſons did not counterbalance the advantages which were likely to reſult, from this journey, to natural hiſtory and geography; but I reflected that the health of my colleague was becoming daily worſe, and that he was incapable of ſupporting the fatigues of travelling ſo far, during the hotteſt ſeaſon of the year. It would have been neceſſary to traverſe the Mazandaran, a hot, marſhy, and extremely unhealthful diſtrict; and beſides this, the dragoman refuſed to accompany us. We then agreed to wait

wait for the king in the environs of Teheran, in order that we might take advantage of the feafon proper for refearches in regard to natural hiftory; for collecting feeds, and for enabling C. Bruguiere to re-eftablifh his health with more facility.

We were obliged to negotiate, and to make fome pecuniary facrifices, before we could obtain permiffion to quit the town, and refide in a village at the bottom of mount Albours. Teheran contained hoftages from all the great cities of the empire, whom Mehemet had caufed to affemble there for his fecurity; fo that people might enter the city, but could not depart from it without the exprefs leave of the governor; and the latter did not let flip fo fine an opportunity of forcing us to expend a little money. As we forefaw that the prefents left behind might be retarded, and not even reach us, we thought it prudent not to make any mention of them. We had it in our power, indeed, to offer the governor a watch and fome arms; but we fhould thus have entered into an engagement to give other prefents to his principal officers, and, on the king's arrival, having nothing fufficiently beautiful to offer to his minifters, and our prefents being detained at Bagdad under a pretence that the roads were not fafe, we fhould have been confidered as impoftors, and fhould have loft that confidence which our conduct ought to have infpired.

The king, after taking poffeffion of Mefched and all Chorazan, and after having deftroyed Charok-Shah the laft defcendant of Thamas-Kouli-Khan, and carried away his treafures, returned to Teheran. He made his entry into that new capital towards the end of September 1796; and, two days after, we had an audience of the prime minifter, with whom we had reafon to be fatisfied. We endeavoured to fecure the friendfhip of the chief fecretary, an active, judicious, enterprifing man, and as well informed as could be expected in Perfia. We fpoke to him of the new government eftablifhed in France; and, at the fame time, made him

him acquainted with its resources, population, triumphs and power. We received from him some interesting details respecting the manners, religion and government of the Persians, as well as a circumstantial history of the troubles which had desolated that unhappy country since the dethronement of Shah Hussein, and particularly since the death of Nadir Shah.

On the 4th of October we obtained from the minister an audience to take leave; and, some days after, his principal secretary gave us a letter addressed to the French republic, a copy of which I immediately dispatched, reserving the original, which I have since presented to the directory.

We now made haste to complete our observations and to return to Bagdad, as we already foresaw the storm which still involves that country in all the horrors of a civil war. We quitted Teheran on the 15th of October, and pursued the road to Ispahan. We had made an ample collection of objects of natural history, and of medals. We had acquired also very correct information respecting the population, revenues and forces of Persia; the late revolution, and the state of its commerce. Our travels, however, would have been incomplete, had we not seen the ancient capital of the empire, and the seat of the sophis. We remained a month at Ispahan, and on the 21st of December arrived at Bagdad.

Some European travellers have traversed Persia, and have given us accounts more or less correct of that empire. They have made us acquainted with the industry and commerce of the Persians; given us long details respecting the religion and followers of Mahomet; and have described the palace and gardens of Shah Abbas and his successors, as well as the public edifices of Ispahan. But the history of the troubles of Persia since the death of Nadir Shah; the changes in manners, agriculture and industry, which must have been effected there by intestine wars, that continued for more than sixty years; the formation of a new empire, more powerful than Persia itself, which extends from Candahar to

Cashmire,

Caſhmire, from Caboul to the country of the Moguls, comprehending the fertile banks of the Indus, cannot fail of giving new intereſt to a new narration. In regard to natural productions, it will be ſeen, by an account of the different objects which I ſhall not fail ſoon to publiſh, how little they are known, and how curious and important the greater part of them are.

Perſia is an elevated country, covered with ſnow in winter from the Caſpian ſea to Iſpahan; and in ſummer, dry and exceedingly warm. It conſiſts of mountains remarkably high, and of immenſe plains, for the moſt part uncultivated. What muſt aſtoniſh every traveller is, that throughout the whole empire no production can be obtained without watering: neither corn nor vines grow there but by means of water. No trees or ſhrubs are ever ſeen, but ſuch as have been planted, reared and watered by the hand of man. Water is every where neceſſary; and yet in this country it is naturally wanting. It was requiſite, therefore, that the induſtry of the inhabitants ſhould ſupply this deficiency by ſubterranean channels, which convey water from all quarters, and end at a common reſervoir. By taking advantage of the declivity of the ground, they then draw off different ſtreams, near which they form habitations more or leſs conſiderable, according as the water, more or leſs abundant, admits of a greater or leſs degree of cultivation.

Though wounded, at the diſtance of ſix days journey from Bagdad, by a band of Curdes, while aſſiſting my colleague when about to fall into their hands, I was, however, ſoon able to continue our journey; but C. Bruguiere, whoſe life was almoſt daily threatened in Perſia, and whoſe health was ſtill uncertain, could not for a long time be prevailed on to proceed. Nearly ſix months elapſed before I was able to perſuade him to ſet out in order to return home. Several times, on the approach of the fine ſeaſon, did I threaten to leave him; but I could never reſolve to do ſo, as my conſcience

ſcience would not have ceaſed to reproach me, had my companion, after my departure, terminated his career at a diſtance from his friend and fellow traveller.

During the time I reſided at Bagdad waiting for the perfect re-eſtabliſhment of C. Bruguiere's health, I employed myſelf in collecting different materials for a hiſtory of our travels. I have ſeen the ruins of Seleucia, Cteſiphon, the ſite formerly occupied by the celebrated Babylon; the towers called thoſe of Nimrod, which neither time nor the hand of man has been able entirely to deſtroy, and which ſtill excite the admiration of travellers.

I had in Egypt and Syria obſerved the Arabs, that nation ſo ſingular, and reſpecting whom travellers have ſpoken ſo differently. I had ſtudied their manners, their cuſtoms, and the form of their government. It ſtill remained for me to live among them, to travel with them, to frequent their tents, and to receive from their hands ſimple, frugal, and wholeſome food.

As particular circumſtances obliged me at Bagdad to exerciſe the functions of a phyſician, I readily embraced that opportunity of ſeeing the interior part of the Mahometan habitations, and of becoming acquainted with the ſtate of their harems, and the women ſhut up in them. No traveller, perhaps, has been able to collect, in this reſpect, ſo many ſingular anecdotes.

We departed from Bagdad on the 1ſt of May 1797, in company with a caravan deſtined for Aleppo. We remained ſixty-five days on the banks of the Euphrates, and in the deſert employed our time in preparing plants, collecting inſects, ſkinning birds and quadrupeds, and in making obſervations on the Arabs; the climate, ſoil, and productions of theſe countries. We made only a ſhort ſtay at Aleppo, where we found a letter from C. Aubert Dubayet, in which, after ſome compliments on account of our conduct, he requeſted we would return by the ſhorteſt route to France.

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This invitation was perfectly agreeable to our wishes; but it was indispensably necessary that we should pass through Constantinople. Could we leave behind us a scattered collection, the fruit of five years labour and observations, exposed to the dangers of the sea and of dilapidation? Is it not certain that objects of natural history, almost all of a perishable nature, must be taken care of during quarantines by hands accustomed to manage them? How easily might manuscripts have been carried away? We had left some boxes under the care of a merchant at Constantinople, and others in an apartment of the ambassador's palace. There was a great number at Scio, and some at Latakia. We considered it as our duty to unite the whole, and to convey them all to Paris ourselves, in order that it might be seen, on our arrival, whether we had accomplished the views of government, and whether we had not deceived the expectations of the learned.

We wrote to the ambassador to make him acquainted with the motives which induced us to take the way of Constantinople. We wrote, at the same time, to the consuls of Tripoli and Cyprus, begging them to inform us when the first ship sailed for the Archipelago; after which we repaired to Latakia, where we found only a wretched Venetian ship, in which the consul advised us not to embark, as the Algerines, for some time past, had insulted the flag of that expiring republic. We then resolved to proceed to Cyprus, and to traverse that island, though in the most dangerous season; to repair afterwards to the coast of Caramania, and to proceed thence to Constantinople, by crossing Asia Minor. This journey was one of the most interesting we undertook, both in regard to natural history and the information we collected respecting the manners of the Turks, in a country little known, little frequented, and yet so worthy of attention.

We arrived at Constantinople in the end of October, and should have departed thence in the Serieuse, some time after, had

had we received our boxes from Scio, and thofe we left at Cyprus. The ambaffador was employed in procuring us a paffage in the Brune to Athens and Corfu, juft at the time of his death. After that event, all our efforts to procure a fafe and direct paffage to France being ufelefs, we thought we fhould be sheltered from all danger, and free from all reproach, if we proceeded to our ifles in the Levant, by croffing the ifthmus of Corinth. It was certainly of much importance for us not to fall into the hands of the Englifh, whofe fhips covered the Mediterranean. It would have given us great pain to fee our enemies profit by our labours, and reap the fruit of all our dangers and fatigues.

We wrote to C. Carra Saint Cyr, *chargé d'affaires* of the republic at the Ottoman Porte, to inform him of our plan, and obtain his approbation; and at the fame time to afk fome pecuniary affiftance, and make him adjuft the ftatement of the fums advanced to us fince our arrival in the Levant. We received a favourable anfwer, and fuch as was fuited to our circumftances.

It may not be fuperfluous here to obferve, that we had for a long time reminded the Porte of the fervices we had rendered to it in regard to the pozzolana; a fervice it perhaps thought it had fufficiently rewarded by the flattering letter which the Reis Effendi charged us to deliver to the minifter of foreign affairs, accompanied with a prefent of 2000 piaftres. We fhould certainly have refufed, from any other government, a fum fo fmall and fo ill proportioned to our labour, expences, and the importance of the difcovery, and, in particular, fo far below the promifes made to us; but a government fo little fufceptible of honeft and generous conduct, would not have been fenfible of the motive of our refufal.

We left Conftantinople with a favourable wind on the 30th of April, in a Turkifh boat we had hired; touched at one of the caftles of the Dardanelles, and different points of

the Troade, and, for the second time, traversed that fertile country. We paid a visit to the ancient site of Troy; saw the sources of the Scamander; went along the shores of the Simois, and thence proceeded to examine the ruins of the Troy of Alexander. We stopped half a day at Ipsera; went on shore at Cape Sunium to see the remains of the temple of Minerva, and arrived at Athens on the 6th of May. We did not remain above twenty days in that city, which exhibits so many beautiful monuments, and calls to remembrance so great events. I have brought with me a plan of the ancient and modern city, by Fauvel; and one of Marathon, which I traced out on the spot. I collected information respecting the present state of Athens and the neighbouring country, to compare it with what it was formerly. I have seen Mount Hymettus, the marble quarries of Pentelica, the cities of Eleusis and Megara. We passed through the Straits of Salamis, where the Persian fleets were destroyed; and traversed the Isthmus to embark again on the Gulph of Lepanto, from which we repaired to Patras.

It was time to terminate our observations on the Ottoman empire, and to quit these countries, now barbarous, though formerly the seat of the arts, sciences and philosophy. It was time to place ourselves under the ægis of the republic. We arrived at Corfu on the 14th of July, after having touched at Cephalonia, Ithaca, and Parga. We performed quarantine for 21 days. It was not yet finished, and we began to think of continuing our journey through Italy, though embarrassed with a considerable collection, when C. Comeyras, commissary general of the directory, arrived. We immediately applied to him in order to procure a passage to Ancona. He gave us reason to hope that he would soon assign to us for that purpose a small vessel belonging to the republic; and, in the mean time, I traversed the island and environs, sometimes alone, and sometimes with my colleague, to procure information respecting the natural productions of

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the country; the ſtate of agriculture, and the improvements that might be made in it; its ports and harbours; the timber of Epirus fit for ſhip-building; the commerce of theſe diſtricts, and the manners and opinions of our new French ſubjects. On the 23d of Auguſt, and 6th of September, I delivered to C. Comeyras two memoirs, the one being a continuance of the other, in order that he might tranſmit them to government.

On the 9th of September we ſailed in the Brune frigate for Butrento, where we ſpent the day, and arrived at Ancona in the courſe of a few days. My colleague, who had been almoſt always indiſpoſed and in a ſtate of ſuffering ſince our tour through Perſia, here terminated his career, on the 3d of October 1798, in conſequence of a malignant fever brought on by fatigue. He has left a family in want, whom I doubtleſs have no need of recommending to the benevolence and juſtice of the government.

I have brought with me, from the countries I have travelled through, a pretty large collection of plants, ſeeds, quadrupeds, birds, reptiles, river fiſh, inſects, ſhells and minerals, as well as of medals, engraved ſtones, and other objects of antiquity. I have Egyptian idols and mummies; a ſelection of drugs, moſt of them unknown in Europe; a ſeries of the medicines employed in Perſia; and, in the laſt place, ſome rare and valuable manuſcripts. I have juſt ſent to the national garden of plants, ſeeds from Perſia, Meſopotamia, the deſert of Arabia, Syria, Cyprus, Aſia Minor and Greece, in order to be there ſown and cultivated. A great number of thoſe which we ſent home before, have been already reared, and are in a thriving condition.

III. *Method*

III. *Method of preparing the Dutch Turnſol Blue**.

IT is well known that the Dutch kept their proceſs for preparing turnſol blue a very great ſecret; and, in order to miſlead the public, pretended that it was made from rags dyed with the juice of the ſun-flower (*Helianthus*), from which it obtained its name. Since the late revolution, however, in Holland, the true method employed by the Dutch for preparing this colour has been diſcovered, and the proceſs is as follows:—That kind of lichen called orchil (*Lichen rocella*), or when that cannot be procured, the large oak moſs, after being dried and cleaned, is reduced to powder, and by means of a kind of oil-preſs the powder is forced through a braſs ſieve, the holes of which are ſmall. The ſifted powder is then thrown into a trough and mixed with an alkali called *vetas*, which is nothing elſe than the aſhes of wine lees, in the proportion of half a pound of aſhes to one pound of powder. This mixture is moiſtened with a little human urine, for that of other animals contains leſs ammonia, by which a fermentation is produced; and the moiſtneſs is ſtill kept up by the addition of more urine. As ſoon as the mixture aſſumes a red colour, it is poured into another trough; is again moiſtened with urine, and then ſtirred round in order that the fermentation may be renewed. In the courſe of a few days it acquires a blueiſh colour, and is then carefully mixed with a third part of very pure pulveriſed potaſh; after which the mixture is put into wooden pails, three feet in height, and about half a foot broad. When the third fermentation takes place, and the paſte has acquired a conſiderably dark blue colour, it is mixed with chalk or pulveriſed marble, and ſtirred well round that the whole may be completely united. This laſt ſubſtance gives the colour no higher quality, and is intended merely to add

* From the *Handlungſzeitung*, by J. A. Hildt, for December 1798.

to the weight. The blue, prepared in this manner, is poured into oblong ſquare iron moulds; and the cakes, when formed, are placed upon fir boards on an airy floor in order to dry, after which they are packed up for ſale.

IV. *On the apparent Converſion of Silver into Gold. By Profeſſor* HILDEBRANT, *of Erlangen**.

THOUGH gold and ſilver have this common property, that they ſhew little affinity for oxygen, and their calces can therefore be revived merely by ignition; their difference in other reſpects is ſo great, that ſcarcely any two metals can be more unlike. Not only is their colour totally different, and the ſpecific gravity of gold far greater than that of ſilver, but ſilver, in the dry way, forms a perfect union with ſulphur; and in the wet way, with the ſulphuric and nitrous acids; whereas gold has no affinity for theſe ſubſtances.

If the tranſmutation of metals were therefore poſſible, the converſion of ſilver into gold would be very improbable. We muſt, however, conſider nothing impoſſible in nature, the impoſſibility of which cannot be demonſtrated *à priori*. Each century, and, in the preſent active age, every ſhort period of a century, diſcovers new phenomena, ſome of which are of ſuch a nature that they would be conſidered as impoſſible, were not their reality fully confirmed by experience.

I entertain no dread then of being ridiculed by the unprejudiced philoſopher, if I call the attention of chemiſts to a phenomenon in which ſilver appears to be converted into gold. It is a well known proceſs, which I repeat in every courſe of my Lectures, to diſſolve ſilver that contains copper in pure nitrous acid, to precipitate the pure ſilver by common ſalt (muriat of ſoda), in the form of horn ſilver (muriat of ſilver), and then to ſeparate the ſilver from the latter by fuſion with mineral alkali. An experienced chemiſt aſ-

* From *Algemeine's Journal der Chymie*, by A. N. Scherer, 1799.

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ſured me, that when ſilver is revived in this manner, it is in part converted into gold. Since that time I have frequently re-diſſolved in pure nitrous acid the ſilver which I obtained from horn ſilver, and always found a ſmall quantity of black powder remaining at the bottom, which ſeemed to have all the properties of gold.

My proceſs for reviving the horn ſilver is perfectly ſimple: I pour into a deep crucible a bottom of alkali an inch high, and form in it a hemiſpherical cavity with the round end of a cupel rammer. I then put the horn ſilver, well pounded, and mixed with as much alkali (neither of them moiſtened), into this cavity, cover the whole with a thin ſtratum of alkali, and apply a ſlow heat, till the whole maſs comes to red fuſion; by which means the revived ſilver is enabled to ſink down and collect itſelf at the bottom. As vegetable alkali (potaſh) produces the ſame effect as the mineral (ſoda), I employ the former becauſe it is cheaper. I find by experience, that, to form a moiſt ball of the horn ſilver and alkali, is not only unneceſſary, but even prejudicial; for the moiſt mixture is tenacious, and unavoidably adheres to the fingers and the veſſels, thereby cauſing waſte. As the horn ſilver is ſo extremely fuſible, and at the ſame time a flux for earths, and as it eaſily penetrates the crucible, the principal object in reviving, according to the above method, is to increaſe the heat by very ſlow degrees, ſuffering the charcoal to burn only gently for two hours around the bottom of the crucible, that the horn ſilver may be in a ſtate of fuſion before the crucible has been long ignited. By theſe means the alkali is enabled to join itſelf gradually to the muriatic acid, and at the ſame time ſo completely that, when the heat is increaſed till the alkali is in a red fuſion, there is no longer horn ſilver but metallic ſilver preſent, which therefore may come in contact with the crucible without any danger.

For diſſolving the revived ſilver I employ nitrous acid, which I firſt purify by barytes from the ſulphuric acid, and

afterwards by ſilver from the muriatic acid. It cannot here be diſcovered how gold could be conveyed to the ſilver by the ſolvent and precipitant employed; and therefore, to appearance, a part of the ſilver is actually converted into gold. Enlightened chemiſts, however, will ſcarcely believe in this tranſmutation, and will rather ſuſpect ſome deception. I confeſs that I do not myſelf believe in it, and I explain the appearance of gold from the revived horn ſilver in the following manner:—Notwithſtanding the great difference between gold and ſilver, ſome ſilver is almoſt always preſent in pure gold; and a little gold is in like manner almoſt always preſent in pure ſilver (in thoſe commonly called pure). The caſe is the ſame in theſe metals when worked, particularly in coins, even where they are not alloyed one with the other. In all the ducats I have hitherto tried, even in thoſe of Holland, I found, on diſſolving them in aqua regia, a little ſilver depoſited in the form of horn ſilver. In all French crowns, even in the fine Harz florins which are perfectly free from copper, I found a little gold, which, when they were diſſolved in the nitrous acid, was thrown down in a dark coloured precipitate, which could not proceed from the alloying. Dutch ducats, for example, are not, as far as I know, alloyed with ſilver; and no one certainly will believe that the gold found in the Harz florins and French crowns was purpoſely added to them. The metal of theſe coins has from nature a ſmall portion of foreign metals; the gold a little ſilver, and the ſilver a little gold, as long as it is not purified by quartation—or the gold by antimony. If a ſolution therefore be formed of ſuch ſilver, the gold remains undiſſolved, and gradually depoſits itſelf at the bottom as a fine black powder.

It may be readily comprehended, that every chemiſt, unleſs he has very little experience in ſuch proceſſes, when he wiſhes to precipitate ſilver as horn ſilver, will firſt pour off and filter the clear ſolution of ſilver and copper from the black gold powder, before he adds the muriat of ſoda. On a haſty

a hafty view, one might conclude, that the gold which is afterwards found in the fame filver, when revived from hornfilver, could not be a portion of the fame gold of which a part had been depofited on the firft folution of the impure filver. But is it not poffible that even when the folution has flood a confiderable time, and the greater part of the gold powder has depofited itfelf, a portion may ftill remain fufpended, and its particles be fo minute as to pafs through the filtre? A well diluted fomewhat ferruginous acid, after diluted pruffiat of potafh (phlogifticated alkali) has been added to it, looks at firft blue, but perfectly tranfparent; yet in the courfe of a few days real Pruffian blue depofits itfelf at the bottom as a fine powder, and then the fluid lofes its colour. The particles of the precipitate are at firft too fine, and appear under too fmall angles, to be diftinguifhed by the eye as folid bodies amidft the fluid. The cafe is the fame with filiceous earth, when the liquor of flints is much diluted; and alfo with gold calx precipitated with the mineral alkali from aqua regia, where the tranfparent colourlefs ley poured off from the firft precipitate, and filtred through eight folds of paper, at the end of feveral days again forms a black depofit.

As my time is fully occupied with the proceffes neceffary for my Lectures, I have not leifure at prefent to examine this circumftance by a feries of experiments. But, perhaps, fome other chemift, by repeatedly diffolving filver and precipitating it by muriatic falt, may be enabled to confirm or refute my opinion.

Obfervations on the foregoing Paper, by Dr. SCHERER.

THE preceding remarks are greatly confirmed by many obfervations already made public. Thus Homberg, in fupport of his affertion that all gold has been once filver, quotes the following experiments: "If you fufe a hundred times in fucceffion 8 or 16 ounces of filver, which, by previous quartation, you are convinced contains no gold, keeping it each time at leaft an hour in fufion, and afterwards feparate

it by the quart, you will be able to separate a considerable quantity of gold, which was not before in it, because you separated by the first quartation all the gold it could contain. Farther, dissolve 8 oz. of silver in aquafortis, separate all the undissolved part, add to it common salt, and edulcorate the precipitate you have obtained and dry it. Mix with it half its weight of well purified regulus of antimony prepared with iron, and distil the whole in a retort over a slow fire. About 3 oz. or more of the butter (muriat) of antimony will pass over, and, when the fire has been strengthened to the utmost, the silver will remain with a part of the regulus at the bottom of the retort. Fuse this silver in a crucible until no more vapour arises, and until all the regulus is evaporated. Then fuse this silver once or twice more in new crucibles with a little borax and saltpetre, and it will become much more beautiful and finer than cupelled silver. If you then granulate this silver and dissolve it in aquafortis, a great many black scales will remain behind, and, on fusing, you will find them to be gold. If you repeat this operation once more with the same silver and a like regulus, a few black flakes only will remain; and the third time there will be none *." Boerhaave says, in his Elements of Chemistry, "If two parts of the precipitated calx of silver, well mixed by trituration with one part of regulus of antimony, be distilled in a retort in a sand bath, pure butter of antimony, equal in weight to the regulus added, will pass over. The silver, with part of the regulus, will remain at the bottom; and, when reduced, always gives real gold †." Kunckel ‡, in like manner, ob-

* See *Memoires de l'Academie de Paris* for the year 1709, p. 133; and Crell's *Neues Chem. Archiv.* vol. i, p. 30.

† Si enim calcis præcipitatæ argenti partes duæ, cum reguli antimonii parte una, tritu bene mistæ distillant ex retorta, igne arenæ, prodit purum butyrum antimonii tanto pondere, quo fuit regulus admistus. Argentum cum parte reguli manet in fundo, *et reductum semper dat verum aurum.* Elementa Chemiæ. Lipsiæ, 1732. Tom. ii. p. 413.

‡ See his *Chem. tractätlein.* p. 146.

tained

tained gold by treating ſilver with common ſalt. M. Cappel, by treating ſilver with arſenic, obtained from four ounces ten grains of gold *. Guyton confirms this experiment, and obſerves that, in this manner, 8 grains of gold are obtained from 1000 grains of ſilver †. The arſenic, in the laſt caſes, was combined with gold. Some very important reſults, in regard to this ſubject, might be obtained by examining the works of the ancient alchemiſts, as all their aſſertions reſpecting real tranſmutation might be explained by mere ſeparation, without allowing them ſo much as ſome have done ‡.

V. *Hiſtory of Aſtronomy for the Year* 1798. *Read in the College de France, Nov.* 20. *By* JEROME LALANDE, *Inſpector and Dean of the College, and formerly Director of the Obſervatory.*

[Concluded from the laſt Volume, page 389.]

I SAW at Straſburgh the firſt ſheets of a new map of Swiſſerland conſtructed by M. Weiſs, to whom M. Tralles communicated his triangles and baſes. This map is extremely well engraved, and gives us an intereſting topography of Helvetia.

I paid a viſit, in my paſſage, to the obſervatory of Manheim, which had afforded me ſo much pleaſure in 1791; but I found the inſtruments packed up in boxes and depoſited in vaults which the bombs had ſcarcely reſpected, and waiting there for peace, without which neither ſcience nor happineſs can exiſt. The miniſter d'Arberg, whom I requeſted to ſecond the zeal of M. Barry, ſhewed me every mark of friendſhip.

* Crell's *Neueſte entdeckungen*, vol. x. p. 136.

† Crell, *ut ſupra.*

‡ See Crell's *Neues Chem. Archiv*, vol. i. p. 212.

On the 15th of December 1797, Tycho Brahe's birth-day, Dr. J. Ch. Burckhard arrived at my house. This able astronomer, born at Leipsic on the 30th of April 1773, came to reinforce the astronomical corps in France; and he is engaged in a German translation of Laplace's *Mechanique Celeste*, or *La Theorie de l'Attraction*, now in the press. This important work will give the last degree of perfection to our tables: two hundred pages of it are already printed.

On the same day I requested General Bonaparte to procure a good instrument for the observatory; and on the 19th of March the government granted me 2000 livres to purchase the seven and a half feet mural quadrant of C. le Monnier. We had long solicited good instruments for the observatory. C. Cassini, when director in 1785, had obtained a fund for that purpose from the minister Breteuil; but he had not time to make use of it. When I was director in 1795 I renewed my solicitations, and we were at length able to procure, the first time, for the most beautiful observatory in the universe, an instrument worthy of France*. The *Bureau des Longitudes* has sent thither an achromatic telescope; but that is not sufficient.

On the 30th of April I requested from General Bonaparte 10,000 livres to erect the mural quadrant and the meridian telescope of the observatory; and to make at Paris observations to correspond with those made by his astronomers. He departed too soon; but Neufchâteau, the French minister, is worthy of remedying that deficiency, and gives us reason to hope for the assistance we stand in need of. C. Lefrançais observed, with a complete circle, the solstices of this year; and I have seen, with pleasure, that the obliquity of the ecliptic corresponds, within a second or two, with the table which I gave in my Astronomy in 1792, and which is employed by most astronomers.

* The expence of building the observatory is estimated at a million of livres (40,000l.), without including the foundations and subterranean places eighty feet in depth.

On

On the 20th of June the Institute decreed the prize for time-keepers, used in ascertaining the longitude at sea, to two chronometers made by C. Louis Berthoud, the going of which was observed by C. Messier and myself during six months. I carried one of them to Gotha; and I had the satisfaction of finding that a journey of two hundred leagues, in a carriage, did not make the change of a second per day in its movement. The Institute will propose, on the 4th of January, as the subject of a prize to be adjudged in two years, the theory of the comet of 1770, which was proposed by the Academy in 1792. It has not hitherto been possible to calculate this comet but in an orbit of five years, and a revolution so short is improbable.

The *Memoirs of the Institute* for the Year IV. have appeared. They contain my *Theory of Mercury*, the result of forty years researches. This was the first memoir read in the first sitting of the first class of the Institute, on the 1st of January 1796.

The *Bureau des Longitudes* has published two volumes of the *Connoissance des Tems* for the years VIII. and IX., the additions to which were edited under my inspection. It has determined that this work, in future, shall contain 500 pages, in order that we may insert in it our observations and calculations. These two volumes contain a number of important articles: new catalogues of the stars; tables of the moon's horary motion by Delambre; observations of Mercury by Vidal, the great and astonishing observer of that planet, to whom we are indebted for being able to say that the observations of Mercury, so rare and so difficult before his time, are at present as numerous as those of the other planets, and leave nothing more to be wished for on that head. He has alone done more than all the other astronomers of the world, either ancient or modern; and we may now dispense with employing our attention on that subject. C. Vidal must make every other astronomer despair of exceeding him.

An intereſting memoir, accompanied with a trigonometrical chart, ſerving to reduce the apparent diſtance of the moon from the ſun, or from a ſtar, to the true diſtance, and to reſolve other queſtions of navigation, has juſt appeared, by J. R. Maingon, *lieutenant de frigate*. This ingenious chart, of great utility to the navy, was engraved by order of the miniſter, and publiſhed at the *dépot*. It will ſupply the place of the large charts of Margetts, and enable navigators to ſubſtitute operations with a pair of compaſſes for calculation.

The Geographical Ephemerides, undertaken by M. von Zach, of Gotha, at the commencement of the year, are a remarkable and uſeful work, as there are found in them every month curious obſervations; information reſpecting new books and charts, new voyages and geographical maps, ſuch as thoſe of Ireland, Africa and the Black Sea, of ſo much importance at a time when the public attention is directed towards theſe countries; alſo portraits, ſuch as thoſe of Herſchel, Delambre, Sir Joſeph Banks, &c.; in a word, every thing that can be intereſting to aſtronomers, geographers and navigators. An extenſive correſpondence with all countries enables M. von Zach to form a mutual communication between learned men, even the moſt diſtant from each other. The only inconvenience is, that the German language is not ſufficiently cultivated in the South. I have requeſted that a profeſſor of German may be eſtabliſhed in the *College de France*, as I am fully convinced of the importance of that language to various branches of ſcience. No journal was devoted to aſtronomy and geography; and there was little reaſon to hope that any of the kind would be undertaken. Adelbulner and Bernoulli had attempted it without ſucceſs. The high eſteem in which M. von Zach is held, has given to his work a ſufficient degree of reputation to enſure a ſale, and conſequently the continuance of this uſeful publication.

M. Martonfi has publiſhed, in Tranſylvania, a deſcription of

of the obfervatory conftructed by Count Bifhop Bathyani at Carlfburg or *Alba Julia,* called alfo Weiffembourg and *Alba Carolina.*

M. Triefnecker, of Vienna, has publifhed a confiderable work on eclipfes of the fun and planets. He has calculated more than 150 obfervations, and the tedioufnefs of fuch labour is well known. Scarcely any thing of the kind had been done in 1760, when I began to give an example of thefe calculations.

We are informed that a volume of Bradley's obfervations, fo long expected, has been publifhed at London. M. de Mendoza publifhed, alfo at London, in 1797, refearches in regard to folving the principal problems of nautical aftronomy, with tables of verfed fines for every ten feconds, and an auxiliary table which reduces the difcovery of the true diftance to the addition of five verfed fines.

We have received the Ephemerides of Bologna for twelve years, from 1799 to 1810, by C. Mateucci, affifted by C. Alamanni, Guglielmini, Sacchetti, and Canterzani the fon. Since the commencement of the prefent century, the Academy of Sciences always publifhed the Ephemerides for ten years. The laft volumes are by Defplaces, Lacaille and myfelf. I finifhed at the year 1800, old ftyle: the embarraffed ftate of commerce prevented me from immediately finding a bookfeller, and I therefore renounced thefe calculations. The aftronomers of Bologna, more fortunate, have fupplied this deficiency; and we fhall have twelve years materials to affift thofe who wifh to make almanacks for that period.

The Ephemerides of Milan contain the refult of an important labour of C. Oriani, on the method of correcting the elements of the tables of Mercury by obfervation; and many interefting obfervations of C. Reggio and De Cefaris.

M. Schröter, of Lilienthal, has publifhed the fecond volume of his *Aftronomical Collections,* which, befides other things, contains the apparent diameters of the fatellites: nine-

nine-tenths of a second for the second; and one second and a half for the third.

M. Bode, at Berlin, has published a new volume of his Ephemerides for the year 1801, and a third supplementary volume; which contain many astronomical observations and memoirs, by the German, French and English astronomers. This work, like that of M. von Zach, is a repertory which no astronomer can be without.

We have received also a folio volume of logarithmic tables, published in 1794, by M. Vega, an officer of artillery in the emperor's service. Wlacq's tables, published in 1628 and 1633, had become exceedingly scarce; they were never reprinted, and yet they were often wanted. M. Vega has, therefore, rendered a great service to mathematics by republishing that valuable edition.

M. Schubert has published, in German, at Petersburgh, a large treatise of astronomy, in three volumes quarto, forming altogether nearly 900 pages.

The *Bibliotheque Britannique* of Geneva, for March and April, contain interesting details respecting the method employed by M. Blair to correct the difference of refrangibility in telescopes. Essential oils, a solution of corrosive sublimate in spirit of wine, with the addition of a little sal ammoniac; butter (muriat) of antimony diluted in a little ether or alcahol, mixed with a few drops of the muriatic acid, answered the purpose extremely well, when inclosed between two lenses of crown glass *. He formed a very good object glass with a solution of sal ammoniac and mercurial sublimate (muriat of ammonia and mercury). He has discovered that these different substances have not a like distribution of colours, as Boscovich remarked in 1765. In short, he has calculated the curves of glasses in such a manner as to correct the aberration of sphericity. This curious paper has been translated into French; but C. Leroy has kept

* Transactions of the Royal Society of Edinburgh, vol. iii.

back

back the manuſcript for three years. We are obliged to C. Pictet for having made it known in his excellent collection the *Bibliotheque Britannique:* the author calls theſe teleſcopes *aplanatic*, or without error.

I have publiſhed a new edition of Rivard's Treatiſe on the Sphere and the Calendar; a well written elementary book, which has been uſeful for half a century. I have added to it the Republican Calendar, remonſtrating againſt the deficiency of intercalation, as the decree of October the 3d 1798 was not in that reſpect agreeable to what I had delivered to C. Romme.

C. François de Neufchateau ſignaliſed his entrance into the miniſtry by ordering an Aſtronomical Bibliography to be printed. I brought with me from Germany a great many articles for this work; and I have found that no kind of bibliography can be complete without the co-operation of many perſons in different countries. The period of the death of the great Copernicus was ſtill a problem, which I reſolved during my journey. He died on the 11th of June 1543, though Gaſſendi and Weidler ſay the 24th of May, and Planche the 11th of July, in the intereſting collection of Ephemerides, where the memorable events of each day are recorded. I have cauſed more than ſixty manuſcripts to be examined in the national library. C. Legrand, one of the librarians of that celebrated repoſitory, gave me an account of many others; ſo that we are making advances in this part of aſtronomical erudition.

We have received the obſervations of C. Ratte at Montpellier, C. Thulis at Marſeilles, and C. Vidal at Mirepoix: thoſe of the laſt-mentioned aſtronomer are of a very extraordinary kind. C. Vidal ſaw Mercury at the diſtance of three-fourths of a degree from the ſun. The beauty of the climate, the perfection of his inſtrument, and the excellence of his ſight, have produced obſervations as valuable as ſingular: I have ſpoken of them before.

The

The direction of the observatory at Amsterdam, belonging to the Society *Felix Meritis*, has been entrusted to M. Calkoen. He has been at Gotha to exercise himself with M. von Zach; and has begun a course of observations which will be useful in a country where none were ever made, though the want of a navy must induce the government to open their eyes in regard to an object so necessary to navigators. In vain did I go to Amsterdam in 1774; the Stadtholder and the Grand Pensionary promised every thing I wished, and did nothing. M. van Swinden afterwards made some exertions, the effects of which begin to be felt.

C. Henry, who went from Manheim to Petersburgh, has been able to restore activity to the observatory of that capital. He has caused to be erected the large mural quadrant by Bird, which had remained a long time in the packing-box, and which Rumouski never made use of.

M. Piazzi, the astronomer of Palermo, is preparing to measure a degree. I have sent him an exact metre, and they are employed on a complete circle.

The minister, Pleville-Peley, has increased the salaries of the astronomers belonging to the marine observatory at Marseilles, where Thulis makes continued and important observations.

The survey of Corsica, or description of that island, begun thirty years ago, has been finished. The large triangles were laid down by C. Tranchot; the minuter operations were performed by a great number of assistants. The minister of finance having commissioned me to examine this labour, I have reason to think that it is sufficiently correct to be taken as a model, should a like plan be adopted in regard to all the departments of France, which would be highly useful.

C. Perny, who had been sent to Belgium, and who, since 1795, has formed forty triangles at Bruges, Ghent, Ostend, Antwerp, Middelburgh, &c. has set out for the Batavian republic,

republic, which promises to furnish him with every thing necessary for continuing that labour.

On the 24th of January the Institute proposed to the Directory to request the different powers of Europe to send learned men to France, to assist in establishing the new measures, and to sanction that establishment. Eleven have arrived from Denmark, Spain, Italy and Holland: from Denmark, M. Bugge, director of the observatory, and known by some important works; from Spain, Messrs. Gabriel Ciscar and Augustine Pedrayes; from the Batavian republic, C. van Swinden and Æneæ, the former well known by some excellent works on natural philosophy; from Tuscany, M. Fabbroni; from Sardinia, Count Balbo, the minister at Paris; from Helvetia, C. Tralles; from the Ligurian republic, C. Moltedo; from the Cisalpine republic, C. Mascheroni, from whom General Bonaparte brought us what will serve as a lesson to our most famous geometricians; and from the Roman republic, C. Franchini.

On the 23d of June the legislative body made a law, that the *Bureau des Longitudes* should preserve the original standard of the metre, or of that new measure destined to be in future the type of all measures, and to prevent hereafter that confusion which has hitherto prevailed in the measures of all countries.

Astronomy has so few proselytes that I am happy in being able to say that Dr. Burckhardt, who came from Gotha last year, continues to labour with us at Paris, and that he is already one of our best astronomers.

Delambre had as assistants in his immense labour C. Tranchot, already well known by the great operations in Corsica, and young C. Pomard, who devotes himself to astronomy, and who cannot fail to make a rapid progress under such a master. Astronomy has need of a few recruits; and I do every thing in my power to procure them; but the career is laborious, and not lucrative: this is sufficient to explain why we have so few.

Blanpain,

Blanpain, born in 1779, who ſaw firſt at Marſeilles the comet of 1797, announces, at the age of nineteen, as much zeal as knowledge. He is diſtinguiſhed by his great learning and good moral qualities. Being obliged to apply to commerce, he is not yet able to indulge his taſte for aſtronomy; but he calculates obſervations, and even makes ſome himſelf.

Young Bernier, of Montauban, applies alſo to the ſame ſcience with ſucceſs. I wiſhed to get him ſent out with General Bonaparte; but my application was too late.

C. Cotilon, though employed in the adminiſtration of domains, has come to lodge in the *College de France*, in order to labour along with us. His intelligence and zeal we often find uſeful.

On the 11th of November C. Caſſini V. aged ſixteen, who has come to reſide in the obſervatory to purſue the traces of his anceſtors, and who diſplays all the zeal which ought to be inſpired by ſuch an illuſtrious name, made his firſt obſervation in the obſervatory of the *College de France*, under the direction of C. Lefrançais. He will ſupply the place of Maraldi IV. who has left us.

After having ſpoken of our acquiſitions, I muſt now ſpeak of our loſſes. In the hiſtory of aſtronomy for the Year V. I announced the death of Toaldo, which happened at Padua on the 18th of November. As I publiſhed a particular eloge of that uſeful aſtronomer in the *Magazin Encyclopedique**, I ſhall here add nothing on the ſubject, except that his place is ſupplied in the obſervatory of Padua by his nephew, M. Chiminello, who was a long time his aſſiſtant.

Bertrand-Auguſtin Carrouge, an aſtronomer of great merit, died on the 29th of March. He was born at Dol on the 8th of October 1741. He calculated a thouſand ſtars for the Celeſtial Globe publiſhed by C. Lamarche, ſucceſſor to Fortin; and he made a great many calculations for the

* Vol. vi. p. 469.

Connoiſſances

Connoiſſances des Temps, and the ſecond edition of my Aſtronomy. He publiſhed ſeveral memoirs in the *Connoiſſances des Temps*; and a few days before his death he delivered to me tables for calculating the phaſes of the moon, better than thoſe which are in Bouguer's and La Caille's Elements of Navigation. They are in the *Connoiſſances des Temps* for 1801. He was exceedingly poor when he was appointed *adminiſtrateur general des poſtes* on account of the eſteem which Reveilliere-Lepaux, the director, had for his merit. His new appointment did not prevent him from applying to aſtronomy: talents rarely conduct to fortune; this only happens when power is united with knowledge.

Alexis John Peter Paucton died on the 15th of June. He was born on the 10th of February 1732, near Luſſan, and is known by his *Metrology*, an immenſe collection of the meaſures of all countries, which appeared in 1780. I propoſed that labour, and furniſhed him with the greater part of the foreign meaſures; but he added many reſearches, diſſertations, and calculations reſpecting the ancient meaſures, population and agriculture. He employed himſelf on other parts of the mathematics, ſuch as the Screw of Archimedes. In the year 1781 he publiſhed a *Theory of the Laws of Nature*, in which he refuted Newton and Nollet, and eſtabliſhed a new geometrical foot of 123$\frac{1}{2}$ lines. In that work he ſpoke of the pyramids of Egypt, &c. He was ſo fully perſuaded of the importance of his diſcoveries, that he aſſumed this motto: *E puteo veritas.* In the laſt place, he was employed in reducing into decimal meaſures the immenſe number of foreign meaſures, when the economy of government ſuppreſſed his ſalary, and plunged him into wretchedneſs and deſpair, which terminated in his death. The Inſtitute is juſt now ſoliciting government to grant ſome relief to his widow and children.

Beauchamp wrote to me, from Arles, that he had loſt his

brother,

brother, the companion of his travels through Arabia; and his pupil Hyacinth Receiveur, who displayed all that zeal and all those good qualities which could be wished. This loss, a very great one to astronomy, threw Beauchamp into despair, and disgusted him with a voyage to Arabia; but the minister sent him to join Bonaparte and the men of letters assembled in Egypt, where he will certainly contribute to the success of that important expedition, in regard to the geographical and astronomical parts.

M. Reccard, who had published various observations, died at Konigsberg on the 3d of October.

We have lost lately also John Francis Calle. He was born on the 25th of October 1744, at Versailles, where he received a good education, and acquired an early taste for the mathematics. In 1768 he came to Paris, where he had an opportunity of being more thoroughly instructed. In 1774 he formed some distinguished pupils for the school of engineers, where the examinations were strict, and admission difficult to be obtained. In 1779 he gained the prize proposed by the Society of Arts at Geneva, for escapements. In 1783 he completed his edition of *Gardiner's Tables of Logarithms*, which were exceedingly convenient, of great utility, and very correct; and which possessed advantages above all the others. In 1788 he was appointed professor of hydrography at Vannes, afterwards at Dunkirk; and in 1792 he returned to Paris, and was for a few years professor *des ingenieurs geographes* at the depôt of war. This place having been suppressed, he continued to teach in Paris, where he was always considered as one of the best mathematical masters to whom pupils could apply.

In 1795 he published the new stereotype edition of the Tables of Logarithms, considerably enlarged with logarithmic tables of the sines, according to the new decimal division of the circle. These are the first which ever appeared. Towards the end of 1797 he presented to the National Institute the plan

plan of a new telegraph, and a telegraphic language, accompanied with a dictionary of 12,000 French words adapted to it by a combination worthy of ſo able a mathematician.

Theſe labours had injured his health; he had been a long time aſthmatic, and notwithſtanding his condition he publiſhed, that year, an excellent memoir on finding the longitude at ſea, under the modeſt title of *A Supplement to the Trigonometry and Navigation of Bezout.* He died on the 14th of November 1798, leaving behind him a daughter, born at Vannes in 1793. According to a tradition in the family, he was deſcended from Deſcartes. I have not been able to obtain the genealogy of his family; but it is ſufficient for the glory of Calle, that he has done honour to a name ſo celebrated.

VI. *Progreſs of Dr.* MITCHILL's *Mind in inveſtigating the Cauſe of the Peſtilential Diſtempers which viſit the Cities of America in Summer and Autumn. Being a Developement of his Theory of Peſtilential Fluids, as publiſhed to the World in* 1795, *and the ſucceeding Years**.

IT had a long time appeared to him, that what had been mentioned by medical writers and lecturers under the names of *miaſma* and *contagion,* was not treated of with the preciſion and certainty of knowledge, but diſcuſſed with all the indiſtinctneſs and conjecture of ſomething only gueſſed at. And, while a ſtudent at Edinburgh, he ſuppoſed the doctrine taught in the univerſity of the *ſedative* operation of theſe poiſons was true, until he heard from Dr. Brown, while attending his lectures, a contrary opinion.

Delivering his ſentiments on *ſtimulants,* Brown had ſaid, "Venena et contagiones incertiùs eodem ſpectant." (Elementa Medicinæ, cap. 2. § XI.) This implied a doubt in Brown's mind, whether theſe claſſes of objects were ſtimu-

* From an American Correſpondent.

lants or not. This doubt is repeated in § XIX. where, expressing his ideas of the manner the exciting powers act upon excitability, he seems to consider poisons and contagions as exceptions to the general rule of action: "nisi quod venena et contagiones excipi posse videntur." And although, in the two following paragraphs, he endeavours to shew that these substances are *stimulants*, and act upon the living body after the manner of other stimuli, still he is so wholly silent as to their nature and constitution, and so entirely destitute of experimental proof or demonstrative reasoning, and withal so brief and general in his remarks, that nothing solid and satisfactory is afforded in that part of his work which treats of these matters.

In conversation with this original though unfortunate man, Dr. Mitchill acquired incorrect information on the matter of these poisonous substances and their manner of acting; the sum of Brown's reasoning but tending to shew that, as all other substances according to his hypothesis were stimulants, *poisons* and *contagions* could not, from the nature and analogy of things, act in any other way than by stimulation too.

Thus it appeared to Dr. Mitchill, when he returned to America in 1787, that that field of physical science, which included the production, operation, and extinguishment of poisonous fluids, lay almost waste and uncultivated. On turning over the Encyclopædia, there scarcely appeared a subject whose investigation promised greater good to mankind, or fairer fame to the investigator, than the history of these noxious productions. Not long after this time the Medical Society of the State of Delaware proposed a prize-question, "What was the hurtful power which produced the febrile distempers of that region?" And Dr. Mitchill was solicited by his friend Dr. Ed. Miller, then secretary of the society, to compete for the prize. But being at that time engaged in the study of the law, and also in the politics of his country as a member of the legislature, he declined undertaking

any

any thing of the kind; but obſerved, " that the miſchievous matter would be found to *be a gas*, and an analyſis of a portion of the atmoſphere there would not fail to detect *what ſort of gas it was*."

Being devoted to other purſuits, the ſubject of poiſons hardly occurred to him afterwards, that he recollects, as a theme for contemplation, until the year 1795, when the following incidents ſet him ſeriouſly to thinking. While on a tour, that ſummer, towards the northern country, he had aſcended towards the ſources of the Kaats-kill, and been engaged among the ſublime and picturesque ſcenery of the Blue Mountains, in the State of New York. On a ſhoulder of the eaſtern ſide of a ridge, called the Pine Orchard, he very narrowly eſcaped being bitten by one of the rattle-ſnakes which infeſt that zone of the mountains. This ſerpent, of the full-grown and largeſt ſize, lay baſking in the ſun-ſhine. The voyager had walked within a foot and a half of him before he was diſcovered. The agitation and whizzing noiſe of his rattle led firſt to his detection. When ſeen, he was bent into a coil, and his head was erected apparently to ſtrike. The ſuddenneſs of the ſurpriſe, and the grand and novel aſpect of the animal, prevented for a moment the emotions of fear. Dr. Mitchill, however, was ſoon brought to his recollection by the cries and ſhouts of his companions, who were terrified at the extremity of his danger. In the mean time the animal crept quietly away, and Dr. Mitchill eſcaped unhurt. By the joint efforts of the company, this ſerpent and his mate were drawn from their lurking-place and killed. In the diſſection of their bodies, in which he was aided by William Cutting, Eſq. and others, Dr. Mitchill had an opportunity of examining their fangs, jaws, and receptacles of venom. So narrow an eſcape, as it induced him to reflect, led him afterwards to conclude, that there was very little of philoſophical information to be derived from Mead's *Mechanical Account of Poiſons*; and that in

 Fontana's

Fontana's *Experiments*, the general exciting caufe of plague and peftilence had been left unexplored.

Another occurrence, during that excurfion, had directed his attention to the fubject of poifons. Dr. William M. Rofs, one of the party, had difcovered that the *Rhus Toxicodendron* grew at the foot of the Blue Mountains. And a parcel of the leaves and ftems of the plant were collected and carried home, with the intent of repeating Alderfon's experiments with this venomous vegetable, on perfons afflicted with palfy.

From this tour as he was returning to the city of New York, he learned with forrow at Paughkeepfie, a town eighty miles diftant, that a malignant diftemper had broken out during his abfence, and that among other perfons Dr. Malachi Treat, then phyfician of the port, had been carried off by it. Haftening back with all fpeed, he faw and converfed with a number of phyficians, and found them divided in opinion, whether the yellow-fever, for fo the difeafe was called, exifted in the city or not. The majority feemed difpofed to doubt or deny the fact. A fhort time, however, was fufficient to convince all perfons whatever, that a fad and terrible malady had made its appearance among the inhabitants.

Impreffed as he was with ideas about poifons, it appeared to him at once, that the exciting caufe of the endemic ficknefs of New York, was as much *a poifon as the fluids fecreted by the rattle-fnake or the toxicodendron*. There was a difference, however, between the venom of peftilence and the poifons ftrictly denominated *animal* and *vegetable*; becaufe the two latter were always the effect of vafcular and glandular action with fecretion in living bodies; whereas the former was the refult of new combinations taking place in organized fubftances during their putrefaction and decay, without any thing like a fecretory function. Herein, then, feemed to confift the diftinction between what might be called Com-

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MON POISON and SPECIFIC POISON; the one being produced *by the corruption of dead bodies,* the other afforded *by ſecretion going on in living ones.*

The deciſive method of gaining information concerning this COMMON POISON (venenum univerſale) muſt neceſſarily be an examination of every individual proceſs going on during the complicated work of animal and vegetable diſorganization. For this purpoſe Dr. Mitchill had planned a ſet of experiments. But, before undertaking theſe, he determined to watch the operation of the poiſon already produced, be it what it might, and obſerve in what manner it wrought the deſtruction of life. And, for this purpoſe, he remained in the city until the ſickneſs was abating; having omitted no opportunity to witneſs and collect facts as they occurred in the midſt of peſtilence and death.

Much obſervation, and in circumſtances where the perſons beſt calculated to make reſearches in ſcience rarely chooſe to expoſe themſelves, had led Dr. Mitchill to believe that the hiſtory of AZOTE, both in living and dead bodies, would throw a world of light upon this department of phyſics. Accordingly he went to Plandome, his country reſidence on Long Iſland, and became convinced, by experiments made on the air extricated in the abdomen of putrefying animals, that it was not merely *carbonic acid gas,* but conſiſted alſo of a large quantity of *azotic air.* It is remarkable, that, to avoid the obloquy too often levelled at experiments, he was obliged to conduct his proceſſes with all poſſible ſecrecy.

But *azotic air* alone ſeemed to poſſeſs too little activity to excite the horrid ſymptoms which conſtituted and characteriſed the diſtemper he had ſo lately witneſſed. Yet he knew, and there was no need of any new experiment to prove it, that this very azote did not always evaporate with caloric in the form of air; but in higher degrees of heat than that of October, when his experiments were made, this *acidifiable baſis* frequently connected itſelf with oxygen, and conſtituted

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a very peculiar and destructive acid. Such an acid poison, he became persuaded, had deprived Mr. Hewson, Dr. Walsh, Mr. Jones, and other dissectors, of their lives, by being admitted to a surface denuded of skin. Dr. Latham's fact of the servant poisoned by touching an agnail on his finger with the flesh of a putrid hare which he was skinning, is of the same kind. Immersion of these carcases in strong solutions of alkaline salts, or the mere sprinkling them with pot-ash or soda, would, he thought, have prevented those unpleasant accidents.

In such cases the product formed by the chemical union of azote with oxygen, mingled with more or less of water, and existing in a liquid form, poisoned only when the parts of a living animal were brought into contact with it, as it bespreads the surface which produced it. But Dr. Mitchill was convinced, that, in higher temperatures, when the surface of the earth was heated to 116 degrees, and even to 130 of Fahrenheit's scale, this liquid poison took on occasionally a vaporific or aërial form, and was copious enough sometimes to taint or infect a chamber, a house, a neighbourhood, or even a city. In the former case it injured none but those who meddled with it, in the spots where it was produced; in the latter it rose into the atmosphere, and sallied forth in quest of prey, to distances indefinitely remote.

About this period of the inquiry Dr. Mitchill made an excursion through a part of the State of New York, in consequence of an appointment from the Society for promoting Agriculture, Arts and Manufactures, to explore the natural productions of the country, and especially to determine whether any mines of coal existed in the neighbourhood of Hudson's River. It did not appear that any considerable quantities of that article of fuel were to be found; but it was ascertained, in the course of the expedition, that, in some of the manufactories, where the alkaline salt of burnt-wood is extracted to form the pot-ash and pearl-ash of commerce, there was enough of *oxygenated azote* in the atmosphere to combine

combine with a portion of the alkali crystallising about the letch-tubs, and to constitute salt-petre. The labourers at pot-ash works, though much exposed to night air, were seldom visited by the ordinary fevers of the climate.

His attention being thus called to the properties of alkalis, was soon engaged in a more minute investigation of the history of pot-ash, by the following incident. Dr. Mitchill received from the Chamber of Commerce in Glasgow, a letter complaining of the bad quality of certain barrels of pot-ash and pearl-ash exported from New York under the inspector's brand, and proved by the bleacher at Paisley, to whom it had been sold, to possess hardly any qualities for whitening goods. This letter was accompanied with a notorial copy of the proceedings in a suit at law brought by the bleacher at Paisley, plaintiff, against the commission merchant in Glasgow, defendant, for damages on account of having sold him unmerchantable alkali; in which the Court gave judgment for the plaintiff. These papers were submitted to the Chamber of Commerce in New York. In consequence of this, Dr. Mitchill was requested by the president of that body, a short time after, to visit with him the stores of the public inspectors of pot-ash and pearl-ash in the city of New York. Among many other facts which were collected during this visitation, it was related by the inspectors, that, while the labourers in the pot-ash store kept themselves at home and were within the influence of the alkali, the pestilential air of the city had not affected any of them with disease; and Dr. Mitchill discovered afterwards, that if these very labourers exposed themselves to the noxious gas in the air abroad, they sickened and died like other people.

While these things were under consideration, the Legislature of the State assembled. At that time there was considerable conversation throughout the United States concerning the internal and domestic means of defending the country from invasion by a foreign enemy. A man appeared with a project for setting up a manufacture of salt-petre in the neigh-

neighbourhood of the city of New York. On this project Dr. Mitchill was confulted. The man's intention was to have petitioned for the privilege of having the dirt and fcrapings of the ftreets as a reward for keeping them clean. And from this mafs of nuifance, *whofe vapour in the hot feafon gave the people their yellow fevers*, he intended to extract the nitre. After much confideration of the project it was finally given up, as about that time the Secretary of State reported to Congrefs that a confiderable quantity of that material had been brought to Philadelphia from fome part of the weftern country, and that any quantity required for the public defence might be procured from that quarter.

From a comparifon of all the facts which had thus come to his knowledge, Dr. Mitchill found that fome of the principles in which he had been inftructed, were not fo well eftablifhed as they ought to have been. A number of the darling prejudices of his education were in danger of being overturned. And he, for fome time, experienced no fmall degree of affliction at the thought of rejecting much of what he had learned from books and lectures, concerning *acids* and *alkalis*, as groundlefs and untenable doctrine.

The fluids, whether liquid or aëriform, which *pot-afh* could coerce, and which, as they emane from putrefying bodies, combine with that alkaline falt into nitre, thus appeared to be the very noxious miafmata which vitiated the atmofphere and rendered it fickly and unwholefome, when there was too little alkali or none at all to attract them. Thefe feemed to be evidence enough to convince him, and any body elfe who would examine the facts as he had done, that fome combination of azote with oxygen was the fimpleft and moft common form of poifon.

At the fame time he was perfectly aware that what he thus called a poifon, was what mankind knew under the name of the *nitrous acid*; that *nitre was called a great antifeptic*; that the acid was claffed among the *mineral* acids, and was reckoned a *great antifeptic too*; with a multitude of fay-

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ings of this ſort. He therefore apprehended that the old and rigid adherents to theſe names, and to the modes of thinking aſſociated with them, would ſcarcely have patience enough to liſten to any moderniſed, or, as they would term it, new-fangled ſtatement of the facts. This difficulty was the more formidable, as it was found neceſſary eventually to make an innovation upon the French nomenclature itſelf.

To facilitate his own conceptions of things, rather than to affect novelty or attract proſelytes, and alſo to render his expreſſions of theſe things more correct and eaſy, he propoſed what he deemed an allowable amendment to the nomenclature, by expunging *azote, azotic, nitrous, nitric* and their *derivatives*, and taking *ſepton* for the radical term, with ſeptous, ſeptic, &c. as the preferable epithets. He conceived he had a right to make uſe of a nomenclature of his own, if he pleaſed; while others, if they preferred it, were at liberty to adhere to the old one.

[To be concluded in next Number.]

VII. *On the Uſe of Calcareous Stones in the Manufacturing of Crude Iron.* By Mr. DAVID MUSHET *of the Clyde Iron Works. Communicated by the Author.*

THE tenacious lava which is formed when iron ores or iron ſtones are fuſed without the addition of any other ſubſtance, firſt led to the application of calcareous earths, in various proportions; that a fluid ſufficiently thin and divided might be formed, and the iron diſengaged from its vitrid connections, precipitated to the bottom of the furnace. If the nature and mixture of the ore are well underſtood, the quantity of lime neceſſary to reſtore a juſt equilibrium of proportion in the lava will be readily attained; the metal, no longer incorporated with or ſuſpended in the maſs, will become completely revived, and flow from the furnace ſufficiently purified from its earthy mixtures.

Before

Before this principle was underſtood and generally acted upon, the reſult in iron, from a given quantity of ore, muſt have been very uncertain, and its real value in the ſmelting furnace falſely appreciated: even at this advanced period of improvement, and attainment of ſcientific knowledge, it is much to be doubted if the principle of application of calcareous earths, in the blaſt furnace, is radically underſtood.

If an almoſt total want of knowledge concerning the nature, proportions, and variety of the earths united to the ores, prevail at the various manufactories of iron in Britain, we are not to wonder that the application of lime-ſtone is ſubject to great error, and productive of hurtful conſequences.

In the ſmelting proceſs the three great ſprings of action and government in the manufacture ought to be—a complete revival of all the metal contained in the ore—to confer value upon it, by reviving it ſaturated with a ſufficient quantity of carbon—and to uſe every endeavour to increaſe the quantity: ſtill, however, keeping in eye the produce of iron from the ore, and its quality; both of which may be eaſily impaired by too much eagerneſs after quantity.

To deprive an ore of its iron, ſo that no portion of it ſhall eſcape in the ſcoria unrevived, two things are indiſpenſible: 1. The metal contained in the ore muſt be preſented to a portion of fuel ſufficient to take up the oxygen from the metal. 2. As this revivification goes on in the manner of a metallic perſpiration upon the ſoftened ſurfaces of the ore, another agent ought to be preſent to facilitate the ſeparation, by uniting with the earthy parts of the ore; forming a thinly divided lava, no longer capable of retaining the globules of metal, or of preventing the congenial affinity of the carbonic principle from taking full effect for the improvement of the quality of the iron.

Experience has ſhewn, that an exceſs of any particular earth may be corrected by applying one oppoſite in its effects; and that the addition of lime, in various proportions, is found in moſt caſes to anſwer the deſired end: this once underſtood,

underftood, it will be eafily comprehended, that as iron ftones and ores poffefs widely different proportions of mixture, their fufion will be productive of vitrid fcoriæ, various in their degrees of divifion and tenacity. This leads to a conclufion, the juftice of which cannot be doubted, that fince the various mixtures of iron ores are productive of lava, which tends more or lefs to keep the iron from feparation, it becomes a neceffary ftudy to obviate the imperfections of fuch mixtures, and at all times to regulate the proportion of the calcareous earth, from a knowledge of thefe mixtures and their effects, and not from an implicit reverence to the cuftoms of a fenior eftablifhment.

If the various claffes of iron ftones are fufed in contact with charcoal, without the addition of a flux or folvent, the refult is, from calcareous iron ftone, a larger portion of iron proportioned to the intrinfic richnefs of the ore, than from argillaceous iron ftone; and from the latter, a larger produce of iron, than from an ore whofe chief mixture was filex: the fcoria produced in the refpective operations always demonftrates, from its colour and opacity, the probable quantity of iron which ftill remains to be taken up.

There are fome calcareous iron ftones which contain lime almoft fufficient to form the neceffary quality of fcoria, the colour of which, when freed from the metal, poffeffes a confiderable degree of tranfparency. When a number of thefe iron ftones are ufed in the blaft furnace, a much lefs quantity of calcareous earths is neceffary. It fometimes happens at iron works, whofe chief fupply is derived from a calcareous field of iron ftone, that, by ufing a great proportion of an individual ore furcharged with lime, the operations of the furnace are obftructed, and confequences entailed fatal to the intereft of the manufacturer. From an excefs of pure calcareous earth being prefent in the furnace, the fcoria, thick and curdled, becomes attached to the fides and bottom of the furnace; the quantity hourly increafes, till it has accumulated to fuch a degree as to intercept the afcent of the blaft,

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and the defcent of the materials. The fource of this evil is juftly attributed to the nature of the iron ftone; but in place of attempting to obviate its imperfections of mixture, it is either totally rejected, or ufed in the moft fparing quantities: whereas, had the quantity of calcareous earth been proportioned to that contained in the iron ftone, the fame ore might have been advantageoufly fmelted, and a confiderable quantity of lime faved. The fame happy effects might alfo have been produced by combining with the calcareous iron ftone, one containing a large proportion of clay or fand; in fome fituations, where a variety of lime ftones are found, the fame confequences may be effected by applying one lefs pure, mixed with a proportion of clay and filex.

A fimilar excefs of clay in the argillaceous genus of iron ftones, is fraught with the fame fatal effects to the produce in metal from the blaft furnace; and many fuch ores of iron are totally rejected, merely becaufe their improper application was found productive of confequent effects. The fufibility of lime and clay, individually, is much facilitated by the addition of fand; and in all cafes where thefe earths exift to excefs in the ores, they ought either to be combined in the blaft furnace with filiceous iron ftone, or treated with a lime ftone containing a confiderable portion of fand.

Again, inftances occur in the manufacturing of crude iron, where ores fufficiently rich in iron are totally rejected, as being incapable of affording a quality of crude iron for the purpofe of melting. It is found that an excefs of fuch iron ftone always changes the colour of the fcoria, and that a confiderable portion of the metal goes to effectuate this change in the ftate of an oxyde united with the fufed earths. Thefe ores are of the moft fufible nature, combined with a heavy proportion of filex; but ftill capable of being treated in fuch a manner as to afford their iron of a valuable quality. When this mixture is fully afcertained, the fufibility of the iron ftone is little impaired, and the quality of the iron mended with an increafe of quantity.

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From this it will appear evident, that the addition of calcareous earths, in juſt proportions, will form with moſt ores a vitrid alloy, thinly divided, and to which the metal has ſo little affinity, that it becomes abandoned by the former at an early ſtage of ſeparation, and, being expoſed to the combination of the carbon, is beneficially and richly revived. In this operation lime may be conſidered as introducing into the furnace a conſiderable quantity of carbonic acid, [it is always uſed in the raw ſtate] which becomes decompoſed in ſuch a manner as to furniſh the iron with a ſmall portion of carbonaceous matter. The effects of this extenſion of principle are however much limited, as the carbon afforded by the decompoſition of the carbonic acid can never enable the iron to take up this principle from it in a crude concrete ſtate, capable of conſtituting fuſibility. It may, however, by uniting to it in a neutral ſtate, call it into metallic exiſtence, and enable the carbon afforded by the fuel to diſtribute its fuſible principle over a larger portion of metal. Lime-ſtone therefore ought never to be conſidered as a general ſubſtitute for fuel in the blaſt furnace, though in ſome caſes the effects produced by its application are ſimilar. Its influence extends no farther than to correct the unequal mixtures of ſome ores, and facilitate their ſeparation and carbonation; an improper application of its kind or quantity may be productive of evils of as great magnitude as thoſe it was meant to remove. In no caſe where a juſt proportion of ores and mixtures exiſt in the furnace, and where the reſult from a real ſcarcity of fuel is oxygenated iron, can the addition of lime confer carbonation to the metal.

Theſe facts render the application of lime-ſtone a matter of attention, and not of chance, depending on an accurate knowledge of the component parts of the ores and their effects, and not on certain portions being cuſtomary at works of ſimilar eſtabliſhment. When a ſcarcity of lime exiſts in the blaſt furnace, and a ſuperior quantity of clay

and silex is combined with the iron stones, the lava will flow from the furnace comparatively cold, tenacious, and of a brown or pale dirty green colour, containing iron: when the mixture is just, the colour of the scoria is pure white, enamelled with a variety of blue shades, waving, circular, or formed in straight delicate lines, arising from a peculiar existing modification of a minute portion of the metal. Should lime be added in excess, the quality of the iron will not be improved, but the quantity considerably diminished. This loss takes place in two ways; when the iron is oxygenated, the presence of an extra quantity of fused earths facilitates the oxydation of the metal, whenever it comes into contact with atmospheric air *. The strong current of air from the discharging pipe affords ample opportunity for this oxydation; the small globules of metal deflagrate and become combined with a great portion of oxygen; the want of carbon in the furnace prevents any part of the oxygen from being again removed; the oxydated iron incorporates with

* As I have frequent occasion to use the two verbs, to oxygenate, and to oxydate, I shall express the precise meaning I attach to two words which are sometimes indiscriminately used, and to which it has been thought that M. Lavoisier had affixed no separate or distinct meaning. I have used oxygenate to express the progressive combination of oxygen with the metal, without, however, destroying its metallic fracture, or exhibiting internally the smallest appearance of an oxyde. Oxydation, on the other hand, I have always used to express the final consequence of the combination of oxygen with iron, and the complete change from a metallic state, to that of a detached friable oxyde. For example, crude iron run from the furnace, of a white fracture, is said to be oxygenated. In cooling, being exposed to atmospheric air, it acquires a considerable quantity of blueish oxyde; its surface may then justly be said to be oxydated. It is the same with malleable iron and steel; each of these suffer in quality from the affinity oxygen has to combine with them, at a high temperature, before the least diminution of metallic fracture takes place; and in that state I have always considered them as oxygenated. When, however, this was past, and the combination of oxygen had destroyed every property of metal, I have considered this only as a state of oxydation.

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the scoria floating upon the surface of the precipitated metal, changes its colour, and in issuing from the furnace conveys a complete change of form and deposition.

Should it, however, happen that an extra quantity of lime is added when the iron is already richly carbonated, then the metal lost is no longer in the state of a fused oxyde incorporated with the scoria, but in small metallic globules, completely enveloped, unable to penetrate the curdled mass and find their way to the bottom of the furnace. This curious phenomenon arises from the peculiar nature of fused calcareous earth, which, while it possesses no great degree of tenacity as a fluid, yet forms a consistency through which iron with all its superior density is not able to penetrate: when cold, such scoriæ have no appearance of vitrification, but are of a straw colour, rough fracture, and very ponderous. I have some specimens of this scoria, obtained from the blast furnace, with triple strata of regularly deposited globules of super-carbonated crude iron, from half an inch to the smallest diameter.

The strict analogy existing betwixt lime stones and ores, in the variety and proportions of the earths combined with each, renders the investigation of both equally necessary, and requisite to be performed in connection with each other.

There are advantages to be derived from a thorough knowledge of the component parts of iron stones, which may not at first sight strike the manufacturer: where a variety of situations offer, this knowledge will direct him to an establishment where the iron stones are of a nature most likely to suit his views. Where melting pig iron for sale is the chief object, calcareous iron stones mixed with silex and nearly destitute of clay possess the greatest advantages. Iron made from this class of ores never possesses any great degree of strength; this, however, in the casting business in general, is reckoned its greatest property; it becomes fused with less fuel, less waste of metal, and the articles made from it exceed those made from stronger iron, in the smoothness of their surface and in the solidity of their parts.

Analogous to thefe facts, we daily fee the fuperiority of fituation evinced, and *cæteris paribus* larger products in iron obtained from a general ufe of calcareous iron ftones than any other. This fuperiority is derived from the congenial mixture of the ore, combined with a large proportion of lime, which facilitates the carbonation of the metal; and united with a juft portion of fand to conftitute fufibility, the fame column of blaft will, in the fame time, reduce a much greater quantity of it, affording the iron at the fame time fufficiently carbonated, than of other iron ftones differently combined.

On the other hand, where the intention of the manufacturer is to fabricate a quality of iron poffeffed of every requifite for converting into good malleable iron, calcareous iron ftones, in quantity, ought to be avoided, and thofe of the argillaceous and filiceous claffes fubftituted. Thofe of equalifed mixtures of earth, combined with pure argillaceous ores, afford the ftrongeft quality of crude iron; capable of being melted to advantage for the conftruction of heavy pieces of machinery, or ufed for the purpofes of the forge. In the ufe of thefe claffes, however, great ftrength and quantity will be frequently found at variance, when the quality of the metal is wifhed to be preferved carbonated: this alfo arifes from the nature of the mixture in the iron ftone; clay in quantity, united with various proportions of lime, forms an alloy, more difficult to fufe than where lime in quantity is united with various proportions of filex.

Where nature has beftowed mixtures productive of every quality of crude iron, the proper arrangement of ores would become fimple and eafy; juft combinations of mixture fuperfede the neceffity of changing the quality of the lime ftone added for a flux, or of having recourfe to various qualities of it, in order to affift or correct the deficiency of the native mixture. Wherever the ores are of a ftructure thus deficient, it then becomes the province of the manufacturer to afcertain the mixture of the individual ores which compofe his fupply,

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and to reftore that equilibrium of parts by the proper application of fuperadded earths, which experiment and obfervation have proved to determine a certain quality of iron.

Thofe works whofe fituation enables them to draw their fupply from fields of iron ftone, impreffed with all the various characters of mixture, poffefs many advantages which thofe more infulated are frequently deprived of. With equal eafe ought the manufacturer to be able in thefe cafes to fabricate with certainty a quality of iron capable of forming to advantage the moft minute piece of cafting, or the heavieft piece of ordnance; at pleafure he might form a quality fit for the forge, or of value in the pig iron market. In fhort, where fuch variety of ores exift, iron of every quality, comprifing fufibility and ftrength, may at pleafure be manufactured, fuited to the many and various wants of a foundry and forge.

Failing, however, of this univerfal affortment of iron ftone, nature has in many places kindly formed a competent fubftitute, in the great variety and quantity of lime ftone which are found within eafy reach of the blaft furnace, poffeffing component parts widely different from each other; from a ftate of the greateft purity, to the heavieft alloy of heterogeneous mixtures; fometimes fo far debafed as not to be juftly appreciated when ranked under the clafs of lime-ftones.

A want of analytical knowledge in the manufacturer may often lead to the purchafe of fuch qualities as may be fuperfluous, from the variety of his ores, or which are diametrically oppofite in quality to thofe which ought to have been applied. I fhall here annex the analyfis of the principal lime-ftones ufed at the Clyde Iron Works, which from their fuperior fituation, having eafy accefs to the eaftern or weftern oceans, can at pleafure draw their fupplies from a greater number of quarters than any other work in Britain.

The filence of provincial hiftorians refpecting the conftituent parts of various limes is a fecond inducement to furnifh fuch a table, which may enable the hufbandman to de-

cide with a juſt preference upon that quality moſt proper for the culture of his grounds. I found chalk to contain car-

bonic acid and water - -	37·3
Silex and a minute portion of clay -	1·045
Lime - - -	61·655
	100 parts.

Iriſh white lime-ſtone.—This beautiful calcareous ſtone is found in various places on the coaſt of Ireland. It greatly reſembles chalk, and differs only from it in its hardneſs, which it derives from a greater quantity of water of cryſtalliſation; it abounds with fine ſpecimens of dog teeth and coxcomb cryſtals; contains a conſiderable quantity of flint in rounded and ovular forms, with very perfect ſpecimens of belemnites. I found this lime-ſtone to contain water of

cryſtalliſation and carbonic acid -	44·5
Silex and a minute portion of clay -	3·7
Lime - - -	51·8
	100 parts.

Iriſh blue lime-ſtone from Learn.—This ſtone is of a dark blue colour, ſmooth fracture, and ſtudded with ſmall ſhining ſpiculæ; it contains no mixture, or form foreign to itſelf. It

contains water of cryſtalliſation and carbonic acid	37·14
Silex - - -	9·43
Lime - - -	53·43
	100 parts.

Arran lime-ſtone, from the Iſland of Arran.—This is a reddiſh-coloured lime-ſtone, abounding with ſuch an immenſe quantity of ſhells, that the whole ſtratum, which meaſures 60 feet in thickneſs, appears to have been formed of ſhells connected by means of a calcareous cement much leſs pure; theſe are all univalve, uncommonly large, ſome of them 6 or 8 inches in diameter, and form the pureſt lime. In calcination this ſtone loſes its colour, and becomes as white as ſnow; perhaps a ſmall portion of iron diſſolved in the

the carbonic acid communicates to it the red colour. I found it compounded as follows: water of cryſtalliſation and

carbonic acid - - -	39·57
Silex - - - -	2·58
Clay - - - -	1·12
Lime - - - -	56·73
	100 parts.

Campbletown lime-ſtone on the Argyle coaſt.—This is a very dark blueiſh-coloured lime-ſtone, of a large granulated metallic fracture, hard and refractory; it preſents no ſpecimens of marine remains, but abounds with a common calcareous ſpar, in which regular form is perceptible; when calcined it retains a delicate tinge of blue colour. I found the component parts of this ſtone to be, water of cryſtalliſation and carbonic acid - -

tion and carbonic acid - -	41·42
Clay - - -	2·407
Silex - - -	2·92
Lime - - -	53·253
	100 parts.

Thornton lime-ſtone, pariſh of Killbryde.—This is a light blueiſh clay-coloured lime-ſtone, ſuſceptible of a fine poliſh, and abounding with a great variety of marine ſhells of various ſizes; the ſchiſtus contains an infinite number of the remains of ſmall fiſhes, ſhells, &c. It yielded water and

carbonic acid - - -	43·91
Silex - - - -	4·67
Clay - - - -	5
Lime - - - -	50·92
	100 parts.

Creſsbaſket lime-ſtone, ſame pariſh.—This ſtone greatly reſembles the former, but poſſeſſes a greater variety of quality, ſometimes inferior, but contains very few ſhells or marine

 remains.

remains. The following are its component parts: water of

cryſtallifation and carbonic acid - -	42·9
Clay, with a ſmall tinge of iron - -	3·3
Silex - - - -	2·7
Lime - - - -	51·1
	100 parts.

Eaſt-Wood lime-ſtone, from pariſh of the ſame name.—This is a ſharp ſplinty lime-ſtone, of an even fracture, but abounding with ſmall ſpiculæ of ſilex; when expoſed to wet for ſome time its ſurface becomes oxydated like an iron ſtone. It contains a great number of univalve and bivalve ſhells, and marine decompoſition of various kinds. It poſſeſſes not the property of falling into lime, unleſs watered when at a red heat; it then forms a coarſe pulverulent earth; of a greyiſh brown colour. It contains water and carbonic acid 27·42

Clay - - - -	3·73
Iron - - - -	5·83
Silex - - - -	36·66
Lime - - - -	26·36
	100 parts.

Lime-ſtone from the neighbourhood of Kirkintulloch.—The appearance of this ſtone is more favourable than the former, though of the ſame inferior caſt; it contains no ſubſtances foreign to itſelf. Its conſtituent parts are, water of

cryſtallifation and carbonic acid - -	37·3
Clay - - - -	12·5
Iron - - - -	3·135
Silex - - - -	8·36
Lime - - - -	38·705
	100 parts.

Kylſyth lime-ſtone.—This ſtone is of a dark blue colour, ſmooth fracture, and ſounds like metal when ſtruck upon. It abounds with the fineſt ſpecimens of pure calcareous ſpars, frequently

frequently refolved into tranfparent cryftals: the chafms where thefe are found are fometimes enriched with beautiful prifmatic pyritical cryftals of a flat fcaly form. The component parts of this lime-ftone are as follow: Water of

cryftallifation and carbonic acid - -	39·52
Silex - - - -	5·73
Lime - - - -	54·75
	100 parts.

From what has been ftated, we are led to inquire into the caufe which produces effects fo widely different in the fufibility and ftrength of crude iron. The exiftence of calcareous, argillaceous and filiceous earths in the blaft furnace, has been mentioned as effecting thefe changes; and it has been alfo noticed that, under certain mixtures of thefe, determinate qualities of crude iron are produced.

If a predominancy of calcareous earth is ufed as the ftandard for comparifon, with a local proportion of fuel, we find that in proportion as the lime is diminifhed in quantity, and clay added through the medium of the ore, the quantity of metal produced will be lefs, but its ftrength greatly increafed; and if the argillaceous ores are pure, the carbonation of the metal will be little altered. Should filiceous mixtures be applied in place of argillaceous, we find that, in proportion as lime decreafes, and the quantity of fand in the furnace is augmented, the quality of the iron becomes lefs carbonated, lefs fufible, and its fmall portion of ftrength greatly impaired: fand through the medium of the ore may be added, fo as to render the iron as brittle as glafs, and as white in the fracture as filver.

Again, let a predominancy of filiceous earths in the blaft furnace be the ftandard for comparifon; in proportion as thefe are diminifhed by the addition of argillaceous ores, the metal will pafs from the ftate of extreme brittlenefs and oxygenation, to a ftate comparatively ftronger and containing more carbon. Should calcareous iron ftones be added, their addition will

immediately correct the pernicious effects of the silex, and facilitate the carbonation of the metal; but will not confer any great degree of additional strength. Lime may be added to such excess as to render the continuity of the particles of iron so small as to be easily divided into granulated masses, forming a true plumbago.

From a consideration of these results, we are led to attribute to calcareous earths the property of facilitating the carbonation of the metal where an improper combination exists; which property is derived from the carbon of the acid with which they are neutralised. To argillaceous ores we ascribe strength, without having the tendency of destroying the carbon, merely because these ores contain a very considerable portion of lime; their union counteracts the natural fusibility imposed by lime, and at the same time is productive of strength. Siliceous iron stones are viewed less favourably, being nearly destitute of lime; the iron in the furnace varies in principle from the development of its mixtures, and only depends upon the quantity of carbon furnished by the fuel to become saturated with a sufficiency to constitute fusibility.

The exclusive predominancy of lime and silex apart tends in the smelting process to reduce crude iron to its two greatest extremes of quality, carbonation and oxygenation; both of which states are equally destitute of strength. Clay acts as the restorer of these disproportions, and by a happy combination produces the medium of the two extremes, which is strength and undiminished quality.

Were siliceous iron stones universally combined with a larger portion of oxygen than the other classes, another clue would be furnished to explain why siliceous mixtures were less congenial to the existence of carbon in the blast furnace, than those of lime and clay; and why the metal obtained from the former is always more oxygenated with the same portion of fuel than that obtained from the latter. Although I am convinced that this frequently is the case, yet, as I have not

not been able to assume an extra fixation of oxygen in siliceous iron stones as an universal principle, I would not wish to apply it, in any great degree, to the solution of the present theory, seeing the causes already advanced are sufficient for an explanation of the whole phenomenon.

VIII. *Account of Bugs found in hollow Trees, with Observations on that Phenomenon. By* S. OEDMAN *.

IT is a well known prejudice among the country people in Sweden, that they believe the house bug takes up its residence in the common yellow wall lichen, which grows under the juniper bushes, &c.; but, as far as I have been able to learn, no entomologist ever yet found the real house bug in standing trees, and therefore the following new observation seems to be worthy of attention. Last August some workmen, who were cutting wood on an island in Nämdö Sound, sat down under a hollow alder tree in order to eat their dinner. One of them having accidentally made a noise near the trunk, aroused a bat (*vesp. murinus*), which was immediately seen to fly out from a hole in the side of it. Being desirous to know whether there were any more animals of the same kind in the trunk, these wood-cutters gave it a violent stroke, and a mass was heard to drop, which one of them pulled out with his hand, and found to consist merely of bugs. It is impossible they could be deceived in regard to vermin so well known; and what rendered the circumstance still more certain, was, that they found under the wings of the bat, real bugs, which had taken up their abode there, together with the usual insects that infest these animals. The whole quantity of bugs amounted to about three quarts. M. Blix, who was at great pains to examine this phenomenon more narrowly, found in the bottom of the

* From New Transactions of the Academy of Sciences at Stockholm, vol. x.

hollow

hollow tree two concave places filled with ftraw and foft earth, in which the bats probably kept their young; for the old ones when they fleep generally fufpend themfelves by the hooks of their wings. Some time after, M. Blix having heard that a bat had been feen to fly into a hollow tree on the ifland where he refided, repaired to the place, and drove from the tree thirty-feven bats. It accidentally came into his head to examine with a ftick the roof of their dwelling; and when he drew out the ftick he obferved the end of it covered with bugs. He made no farther examination till a few days before Chriftmas, when the tree was felled; but at this time neither bats nor bugs were to be feen. He, however, difcovered that this tree had lodged guefts of various defcriptions; for the lower part had been inhabited by bats; the roof of the cavity by bugs; the middle by nut-peckers, and the top of the tree by a fquirrel. It is not altogether improbable that the bugs had been carried thither from fome habitation by the bats, efpecially as they were found, in the firft cafe, on an ifland totally feparated from the continent, and on which there was not a fingle houfe. It is more difficult to explain how fuch a multitude of bugs could find nourifhment on two or three dozen of bats; but inftances have been known of ftone buildings infefted with fuch vermin, remaining above a year uninhabited, and yet thefe infects, fo far from being extirpated, have not even been leffened. We can fcarcely then give any other explanation, than by fuppofing that bugs eat each other when they have no other nourifhment; and that the lofs thence occafioned is fupplied by their great multiplication. The caufe why no bugs were found when the laft mentioned tree was felled, may have been, that they were deftroyed by the birds. In confirmation of the above, M. Carlfon adds the following circumftance: "In the year 1777," fays he, "I found an old rotten ftake, that had been ufed for a fupport in a hedge, which was fo covered with houfe bugs that it refembled an ant-hill: it lay at a great diftance from either houfes or gardens,

dens. I inquired whether this ſtake had, at any time, formed part of a building, or been near one; but I was aſſured by a peaſant that he had cut it down not far from the ſpot, and that it had never been employed for any other purpoſe. As this ſtake was not hollow, and could afford no ſhelter to bats, it does not appear how theſe bugs could be conveyed to it from a houſe. There is reaſon to conjecture, rather, that theſe inſects live and propagate even in timber. That they are able to endure the winter cold is beyond all doubt. I expoſed a piece of furniture to the open air for three years, and every ſummer bugs were obſerved upon it in great abundance.

IX. *Obſervations on Animal Electricity; being the Subſtance of two Letters from* A. VOLTA *to Profeſſor* GREN *.

IF a tin baſon be filled with ſoap-ſuds, lime-water, or a ſtrong ley, which is ſtill better, and if you then lay hold of the baſon with both your hands, having firſt moiſtened them with pure water, and apply the tip of your tongue to the fluid in the baſon, you will immediately be ſenſible of an acid taſte upon your tongue, which is in contact with the alkaline liquor. This taſte is very perceptible, and, for the moment, pretty ſtrong; but it is changed afterwards into a different one, leſs acid but more ſaline and pungent, until it at laſt becomes alkaline and ſharp in proportion as the fluid acts more upon the tongue, and as the activity of its peculiar taſte and its chemical power, more called forth, produce a greater effect in regard to the ſenſation of acidity occaſioned by the ſtream of the electric fluid, which, by a continued circulation, paſſes from the tin to the alkaline liquor, thence to the tongue, then through the perſon to the water, and thence to the tin again. I explain the phenomenon in this

* From *Neues Journal der Phyſik*, vol. iii. p. 4, and vol. iv. p. 1.

manner,

manner, according to my principles; and indeed it cannot be explained in any other, as every thing tends to confirm my affertion, and to prove it in various ways. The contact of different conductors, particularly the metallic, including pyrites and other minerals as well as charcoal, which I call dry conductors, or of the *firft clafs*, with moift conductors, or conductors of the *fecond clafs*, agitates or difturbs the electric fluid, or gives it a certain impulfe. Do not afk in what manner: it is enough that it is a principle, and a general principle. This impulfe, whether produced by attraction or any other force, is different or unlike, both in regard to the different metals and to the different moift conductors, fo that the direction, or at leaft the power, with which the electric fluid is impelled or excited, is different when the conductor A is applied to the conductor B, and to another C. In a perfect circle of conductors, where either one of the fecond clafs is placed between two different from each other of the firft clafs, or, contrariwife, one of the firft clafs is placed between two of the fecond clafs different from each other, an electric ftream is occafioned by the predominating force either to the right or to the left—a circulation of this fluid, which ceafes only when the circle is broken, and which is renewed when the circle is again rendered complete. This method of connecting the different conductors will be more readily comprehended by turning to the figures, (plate I,) where the capital letters denote the different conductors or exciters *(moteurs)* of the firft clafs, and the fmall letters thofe of the fecond clafs. Fig. 1 and 2 exprefs the two cafes above mentioned.

I confider it as almoft fuperfluous to obferve, that when the circle confifts merely of two kinds of conductors, however different or however numerous the pieces may be of which each confifts (as fig. 3, 4, 5 and 6), two equal powers are oppofed to each other; that is, the electric fluid is impelled with equal force in two different directions, and confequently

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no ftream can be formed from right to left, or contrariwife, capable of exciting convulfive movements.

There are other cafes, however, and other modes of combination, where the powers are equally in equilibrium, and where no current of the electric fluid can take place; or, at leaft, none of fuch a force as to make an impreffion on the tendereft nerves, or to excite any convulfive movement in the beft prepared frog that may be placed in the circle, notwithftanding the intervention of two or more different kinds of metals. This is the cafe when each of thefe metals is placed between two moift conductors, or of the fecond clafs, and which are very nearly of the fame kind, as fig. 7; or when, in a circle of three pieces, two of them of the fame metal, and one of a different metal, are fo connected, that the latter is immediately between the other two, as fig. 8.

When one of the ends of the middle piece of metal A is immediately applied to one of the two pieces Z, but, inftead of immediately touching with the other end, the other piece Z touches an intermediate conductor of the fecond clafs, either great or fmall, either a drop of water, a piece of raw or boiled flefh, or of fponge not moift, pafte of meal, jelly, foap, cheefe, or the white of an egg boiled to hardnefs, in this new combination, reprefented by fig. 9, (where a conductor of the fecond clafs *m* is between two of the firft clafs, A and Z) the powers are no longer oppofed to each other; and this is fufficient to determine an electric ftream. When *g*, therefore, in fig. 9, is a prepared frog, it will always be violently agitated as often as this circle is made complete.

It may be readily perceived that the two laft experiments, reprefented by fig. 8 and 9, coincide with thofe announced by M. Humboldt, where a drop of water, a fmall bit of frefh meat, or a very thin ftratum of any fluid, performs the whole wonder. When another drop of water, or any other aqueous conductor, is applied betwen the other end of A and the other correfponding piece Z (as fhewn fig. 10), each piece of metal is infulated, as I fhall exprefs it, between two

aqueous

aqueous conductors: but then the powers from right to left, and from left to right, are again completely opposed to each other; consequently the electric stream is impeded, and the frog remains without any movement. It is, therefore, absolutely necessary that two different metals or conductors of the first class should be in immediate contact with each other, on the one side, while with their opposite ends they touch conductors of the second class.

We might consider this mutual contact of two different metals as the immediate cause which puts the electric fluid in motion, instead of ascribing that power to the contact of the two metals with the moist conductors. Thus, for example, in fig. 1, instead of admitting two different actions, at least, in regard to the magnitude of the power, one where A comes in contact with *a*, and another where Z comes in contact with *a* also, by which an electric current arises in the direction from Z to A, we might suppose only one action at the point where A comes in contact with Z, which impells the fluid in that direction. In both suppositions the result, as may be easily seen, is the same. But though I have reasons for adopting the first as true rather than the second, yet the latter represents the proposition with more simplicity, and it may be convenient to adhere to it in the explanation, as it affords a readier view of it. We may then say, that in the cases of fig. 3, 4, 5, 6, 7 and 10, no effect will be produced, because here there is no mutual contact of different metals: that the effect also, according to fig. 8, will be null, because A, on two opposite sides, is in contact with Z and Z, and the actions therefore are in equilibrium; and lastly, that an electric current will be occasioned in fig. 9, by the action which arises from the contact of A and Z, and which is counteracted by no other contact of the like kind.

Having seen the result of employing three pieces of metal, or conductors of the first class, viz. two of one kind and one of a different, when combined sometimes in one way and sometimes in another with conductors of the second class,

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we ſhall now try what will be the reſult, according to my principles, with four pieces of metal, two of which are of one kind; for example, zinc, when connected with moiſt conductors of different kinds.

I ſhall firſt obſerve, that when they are connected in a circle, as at fig. 11, the powers which endeavour to put the electric fluid in a ſtreaming movement will be oppoſed to each other, and in perfect equilibrium, and that conſequently no movement can take place in the frog, here ſuppoſed to be the moiſt conductor *a* or a part of it, however irritable and well prepared it may be; and if the experiment be made with accuracy and the neceſſary precaution, ſo that the metals, in particular, be very clean and dry at the points of contact, it will perfectly confirm what I have above ſaid: the frog will experience no agitation, no convulſive movement.

Theſe movements, on the other hand, took place, as might be foreſeen from my principles, as often as I omitted one of the middle pieces, or changed the order.

The conductors of the ſecond claſs, which in all the figures are denoted by ſmall letters, may be cups with water, in which the ends of the pieces of metal denoted by the large letters are immerſed; or ſponges or other bodies which have imbibed aqueous moiſture. They may be either large or ſmall; and may conſiſt of one or more pieces, provided they be in proper contact: they may alſo be perſons, if their ſkin be moiſtened at the places of contact, &c. By the laſt method the experiments will be very beautiful and inceſſant, when the circle conſiſts of three or more perſons (I have formed it frequently of ten and even more), of two or more frogs properly prepared, and of four pieces of metal, two of ſilver and two of iron, tin, and particularly zinc. The change of effect, when you change the connection, is ſtriking.

Let the poſition be as repreſented in fig. 12, where *g* is the prepared frog, which the two perſons *p*, *p*, hold in their hands, one on the one ſide by the feet, and the other on the oppoſite by the rump. Z, Z are two plates of zinc, which

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are held alſo by theſe perſons, and A, A, two pieces of ſilver, which are held by a third perſon, denoted alſo by *p*. It muſt not be forgotten that the hands ſhould be very moiſt, as the dry ſkin is not a conductor ſufficiently ſtrong. As in this chain the actions of the electric exciters are oppoſed to each other and in exact equilibrium, as may be readily perceived, no convulſion or agitation in the frog will take place.

Now, let one of the metallic pieces A, Z, which ſtand between the two perſons *p*, *p*, or between any other moiſt conductors, be left in combination as it is; and let the poſition of the two other metallic pieces A, Z, be reverſed, by converting fig. 12 into fig. 13 (ſo that the actions, inſtead of being contrary, will act together to impel the electric fluid to one ſide or to produce the ſame current); or introduce between A and Z another perſon, or any other conductor of the ſecond claſs, ſo that the chain be formed as in fig. 14; or take away one of the pieces A, Z, in fig. 12, and make the chain like thoſe of fig. 15 and 17; or, in the laſt place, remove the whole two pieces A, Z, either in the one or the other ſide, as repreſented fig. 17 (by which means it will correſpond with fig. 1, as the whole chain *p*, *g*, *p*, *p*, may be conſidered as a ſingle moiſt conductor of the ſecond claſs); in all theſe combinations, which are repreſented by fig. 13, 14, 15, 16, and 17, the actions ariſing from the metallic contacts are no longer contrary to each other, or in equilibrium, as they were in fig. 12; conſequently an electric ſtream is produced, and the frog *g*, which I ſuppoſe to be properly prepared, and which forms a part of the chain, will be violently agitated as often as the circle, when broken at any one place, particularly between metal and metal, is again reſtored.

In regard to the experiment where a moiſt conductor, or one of the ſecond claſs, is to be introduced between the two pieces A, Z (fig. 14), that is, between two different metals, a drop of water, or a ſmall bit of moiſtened ſponge, or a thin ſtratum of any fluid, ſoap, or any other viſcous matter, will be quite ſufficient, as I have already obſerved reſpecting fig. 9.

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This surprising experiment I generally make in such a manner, that, instead of the piece of metal, I employ a cup or spoon filled with water, and then cause the person who holds the perfectly dry and pure stick of tin to touch with that stick sometimes the perfectly dry sides of the spoon or cup, and sometimes the water contained in them. It is wonderful to see, that as by the latter method the violent agitation of the frog never ceases, the first method, which corresponds with fig. 12, does not produce the least irritation; unless by accident there be a small drop of water, or a thin stratum of moisture, at the place of contact, by which the case represented fig. 14 would be restored. This may serve to shew with what care and attention the experiment must be made, in order to guard against error or deception, which might so easily arise, and every where exhibit anomalies.

When I introduce water or any other moist body, great or small, not merely between one pair of metallic pieces A, Z, as fig. 14, but between two pairs, as represented fig. 18, each piece of metal is between like moist conductors, and by these means all the actions are again rendered contrary or brought into equilibrium; or, according to the other mode of viewing the matter, there is no longer any action, for want of the mutual contact of two different metals, which, as we have seen, is certainly necessary to excite an electric current; and it is always found that the frog experiences no agitation.

I shall not enlarge farther on these combinations, which may be varied ad infinitum with a greater number of metallic pieces, and by which one may be enabled to foretel the phenomena which, according to my principles, will always be found to take place. It will be sufficient, for the present, to draw this conclusion, that in a circle consisting merely of two conductors, however different they may be, their mutual contact can produce no electric stream sufficient to excite sensibility or muscular movement; and that, on the contrary, this effect infallibly follows as often as the chain is

formed of three conductors, one of one clafs, and two different from each other of another clafs, which come into mutual contact with each other, and that this effect will be ftronger the greater the difference is between the latter; that in other cafes, where there are more than three different conductors, the effect either is not produced or will be produced in different degrees, according as the forces, called forth by the different combinations, which will be expanded at each heterogeneous contact, and which are often in oppofition and endeavour to impel the electric fluid in oppofite directions, are perfectly in equilibrium with each other, (which muft be a very rare cafe) or when the fum of thofe which exert themfelves in one direction is more or lefs exceeded by the fum of thofe which act in another direction.

I fhall here however leave the two complex combinations, and return to the fimple cafes, thofe with three different conductors, reprefented by fig. 1, which are more demonftrative; or, in other words, thofe with two different metals or conductors of the firft clafs which are in contact with each other, and are applied on the other fide to moift conductors or conductors of the fecond clafs. This method has been commonly employed fince Galvani's difcovery, and is in exact proportion with the diverfity of metals on which I confider the whole phenomena to depend.

The other method of combination, which is expreffed by fig. 2, or that of a metal placed between two different moift conductors, for example, between water on the one fide, and an aqueous, faponaceous, or faline fluid on the other, I difcovered in the autumn of 1794; and though fince that period I have repeated the much varied experiments of different perfons, both foreigners and others, among which was that of M. Humboldt, and though I wrote to feveral correfpondents refpecting it, that light has not yet been thrown on this new phenomenon which it feems to deferve.

The fingular circumftance before mentioned, in regard to the acid tafte when the tongue is brought into contact with

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an alkaline liquid, belongs, as you may perceive, to this second method of exciting the electric fluid and putting it in circulation (if the tin veſſel be touched on the outſide by the hand moiſtened with water, and on the inſide by the alkaline liquor), and ſhews that this current is no leſs ſtrong and active than that excited by the firſt method, viz. by employing two ſufficiently well choſen metals, ſuch as lead and copper, iron and ſilver, zinc and tin. I muſt here obſerve, that though with tin alone, placed between water and an alkaline liquor, you obtain nearly the effect which is produced by two of the moſt different metals, as ſilver and zinc, combined with any conductor whatever of the ſecond claſs; you can obtain the ſame, and even in a higher degree, with iron alone or ſilver alone, when the iron is introduced between water on the one ſide and nitrous acid on the other, or when the ſilver is applied between water and a ſolution of ſulphure of pot-aſh.

If you take a frog, the head of which has been cut off, and which has been deprived of all life by thruſting a needle into the ſpinal marrow, and immerſe it, without ſkinning it, taking out the bowels, or any other preparation, into two glaſſes of water, the rump into one, and the leg into the other as uſual, it will be ſtrongly agitated and violently convulſed when you connect the water in both glaſſes by a bow formed of two very different metals, ſuch as ſilver and tin or lead, or, what is better, ſilver and zinc; but this will by no means be the caſe when the two metals are leſs different in regard to their powers, ſuch as gold and ſilver, ſilver and copper, copper and iron, tin and lead. But what is more, the effect will be fully produced on this ſo little prepared frog when you immerſe in one of the two glaſſes the end of a bow merely of tin or zinc, and into the other glaſs the other end of this bow which has been rubbed over with a little alkali. You may perform the experiment ſtill better with an iron bow, one end of which has been covered with a

drop or thin coating of nitrous acid; and beyond all expectation, when you take a ſilver bow having a little ſulphure of pot-aſh adhering to the end of it.

Fig. 19 repreſents the form of this experiment, where *g* is the frog, *a*, *a* the two glaſſes with water, A the bow formed of one ſingle metal, and *m* the drop or a thin ſtratum of a mucous, ſaline, &c. fluid with which the bow has been rubbed over, and which on this ſide is between the metal and the water.

[To be continued.]

X. *Agenda, or a Collection of Obſervations and Reſearches the Reſults of which may ſerve as the Foundation for a Theory of the Earth. By* M. DE SAUSSURE *.

[Continued from page 299 of Vol. III.]

CHAP. XV.

Obſervations to be made on primitive Mountains.

1. WHETHER there be any exception to the generally received opinion, that, in primitive mountains, no veſtiges are diſcovered of organiſed bodies.

2. Whether it be true that in theſe mountains no indications are found of bitumen or marine ſalt.

3. To endeavour to determine the reſpective ages of the different kinds of primitive mountains; both compound, ſuch as granite, porphyry, gneiſs; and ſimple, as ſlate, ſerpentine, and primitive calcareous.

4. Whether, in particular, it be certain that granite is the moſt ancient ſtone of all thoſe which form the outer cruſt of our globe, ſo that it is never found placed above (*ſuperpoſé*) any other kind of ſtone.

* From Journal des Mines, No. XX.

5. Whether

5. Whether the large mountains compofed of granite in one mafs, even the beft characterifed, do not give certain indications of ftratification or divifions by ftrata, though lefs regular than thofe of fchiftous mountains.

6. Whether in the bafes of granite mountains the manifeftation of ftrata be not hurt by the number of fiffures, or fpontaneous and irregular divifions.

7. Whether, even in the feparate blocks of granite, an attentive eye does not difcover fome veins of mica, which affect the fame direction, and fuch veins as induce the workmen, who wifh to make mill-ftones or other works more extenfive in one direction than another, to prefer attacking the ftone in a determined direction.

8. Whether the indications of the ftratification are not obferved in the interior part of granite mountains, as well as near their furface.

8. A. Whether among the granites in a mafs, and thofe decidedly veined, there are not found fuch intermediary fhades that it is difficult to mark the line of feparation.

9. To determine the diftinguifhing characters of granites of modern formation.

11. To afcertain the truth of the affertion of the Pliny of France, that in proportion as people dig into a mountain, the fummit and fides of which confift of granite, the granites, inftead of being found more folid and more beautiful the farther they advance, change, on the contrary, below a certain depth, lofe themfelves, and at laft vanifh by gradually affuming the coarfe (*brute*) nature of the live quartzy rock*.

12. Whether it be true that each primitive mountain is generally compofed of one fingle ftone, and of the fame nature.

13. To examine whether there be found on the primitive mountains, at great heights, the fcattered wrecks of fecondary mountains. For my part, I never found any.

14. Whether primitive calcareous ftone be found always

* Mineraux, p. 105.

with a granulated fracture, or the form of a saline marble, and never under a compact form.

15. Ought the porphyric schist of Werner, or the *porphyre schisteux à pâte* of primitive petro-silex, to be considered as primitive or secondary? The same question in regard to the *mandelstein* or amygdaloid.

16. Is it fully ascertained, as I thought I observed in the Alps, and M. de Fichtel in the Carpathian mountains, that there exists pudding-stone or free-stone, if not primitive, at least of a formation anterior to that of all the other secondary stones?

17. Were the granites in a mass first deposited, because they were less soluble? and did they crystallise after the quantity or dissolving force of the waters began to diminish? and was it for a contrary reason that the gneiss, mica and magnesian stones crystallised later?

CHAP. XVI.

Observations to be made on Transitions.

1. To observe the intermediary genera and species of fossils, between one genus or one species of fossil, and the genera and species which have the greatest resemblance to them.

2. To observe, above all, the transitions through which nature has passed, when, having produced one genus or one order of mountains, she began to produce a different genus or order; for there is no change of order which has not been the effect of a revolution; and it is in the transitions that traces of these revolutions are to be found.

3. Thus we often see strata of free-stone or pudding-stone interposed between the primitive and secondary mountains; *breches* are seen to form the most elevated stratum, and consequently the newest of some calcareous mountains. We must study then the nature, dimensions and position of these remarkable strata.

4. Having

4. Having found these transitions, or any others, in some mountains, if they are not then found in other mountains, you must examine whether their absence does not arise from their having been destroyed; vestiges of them are to be sought for; and if it appears that they never existed, you must endeavour to discover, in the nature and position of the mountains, what may have been the cause of their absence*.

[To be continued.]

XI. *Observations on the Manufacture of the Acetite of Copper or Verdigrise, Verdet, &c.* By J. A. CHAPTAL.†

THE acetite of copper is one of the preparations of that metal most frequently used in the arts. It is not only one of the principal resources of painting, but upon many occasions is employed with great advantage in dyeing. Almost all the oxydes of copper obtained by the action of saline substances have a blue colour, more or less inclining to green, and almost all the neutral salts corrode the metal, and produce that oxyde which is called verdigrise. It is sufficient to bring them into contact with the copper, or to immerse the metallic plates in a saline solution, and afterwards to expose them to the air to dry.

Those acids which oxydate the copper by their decomposition, produce an effect like that of neutral salts. The oxyde is of a soft blueish-green colour; their action is so speedy, that if the copper be exposed to the vapour of them for some minutes its surface will be immediately oxydated. The oxygenated muriatic acid produces that effect as well as the vapour of the nitric acid, and even those of the sulphuric acid. A phenomenon which cannot escape the eye of an

* The best method of observing mountains, in order to acquire a thorough knowledge of them, is, not to confine oneself merely to follow the valleys, but to intersect also, as much as possible, the principal chains and the branches detached from them in the direction of their breadth. C.

† From Annales de Chimie, No. LXXV.

obferver, is, that the oxydes of copper obtained by fire are very different from thofe produced by the decompofition of acids on that metal. The colour of them is grey, inftead of being green; and when the calcination is continued a long time at a violent heat, they may be concentrated to a red oxyde of a blood colour. This phenomenon was obferved by Kunckel in his chemical laboratory.

Saline fubftances are not the only ones capable of oxydating copper green. All oils and fat matters produce the fame effect. Even water, when left for a confiderable time in copper veffels, caufes an oxydation. But what will appear very extraordinary is, that the greater part of thefe fubftances have no fenfible effect upon copper, except when cold. Thofe falts even which corrode that metal when left at reft in veffels, do not attack it in fo fenfible a manner when in a ftate of ebullition.

Of all the preparations of copper by oxydation, there is none more valuable than that made by vinegar. All the verdigrife ufed in commerce is prepared by that acid, and it is at Montpellier in particular and in the neighbourhood, that the manufactories of it are eftablifhed. In the Memoirs of the Academy of Paris for 1750 and 1753, may be feen a very exact defcription of the procefs then followed at Montpellier for making verdigrife; but as that procefs has been much improved, and as at prefent the hufks of grapes are employed inftead of the ftalks, a method far more economical, fince wine is no longer ufed, the following account of the manner of manufacturing verdigrife, as now practifed, may be of utility to the public.

The firft materials ufed for this purpofe are copper and the hufks or fkins of grapes left after the laft preffing. The copper employed was formerly all imported from Sweden; but at prefent it is brought from different foundries eftablifhed at Saint Bel, Lyons, Avignon, Bedarieux, Montpellier, &c. It is in round plates half a line in thicknefs, and from twenty to twenty-five inches in diameter. Each plate at Montpellier

Montpellier is divided into twenty-five laminæ, forming almoſt all oblong ſquares of from four to ſix inches in length, three in breadth, and weighing about four ounces. They are beat ſeparately with the hammer on an anvil to ſmooth their ſurfaces, and to give the copper the neceſſary conſiſtence. Without this precaution it would exfoliate, and it would be more difficult to ſcrape the ſurface in order to detach the oxydated cruſt. Beſides this, ſcales of pure metal would be taken off, which would haſten the conſumption of the copper.

The huſks of grapes, known at Montpellier under the name of *racque*, were formerly thrown on the dung-hill after the poultry had picked out the ſmall ſtones contained in them. At preſent they are preſerved for making verdigriſe, and ſold at the rate of from fifteen to twenty livres per *muid*. The preparation of them is as follows: After the vintage is finiſhed, the huſks are ſubjected to the preſs, in order to extract all the wine with which they may be impregnated, and they are then put into vats, where they are preſſed down with the feet to fill up all the vacuities and render the maſs as compact as poſſible. The coverings of theſe vats are carefully faſtened down, and they are preſerved for uſe in a dry cool place.

Theſe huſks are not always of the ſame quality: when the grapes contain little of the saccharine matter, when the ſeaſon has been rainy, the fermentation incomplete, or when the wine is not generous, the huſks are attended with ſeveral faults. 1. They are difficult to be preſerved, and there is great danger of their ſoon being ſpoilt. 2. They produce very little effect, cannot be eaſily heated, ſend forth very little of the acetous odour, and make the plates of copper ſweat without ſhewing efflorеſcence on their ſurface. Independently of the nature of the grapes and the ſtate of the wine, the quality of the huſks varies alſo according as they have been expreſſed with more or leſs care. Huſks which have not been much preſſed, produce a far greater effect than thoſe which have been dried. To explain their different effects,

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it will be sufficient to observe that their action is proportioned to the quantity of wine they retain, as it is that liquor alone which can pass to the state of vinegar. When the husks therefore are destined for a verdigrise manufactory, care must be taken to express them only weakly, in order to preserve more of their acidifiable principle.

When a sufficient quantity of copper and of husks has been provided, nothing remains but to proceed to the operations, which are generally performed in cellars. They may be performed also on a ground floor if it be somewhat damp, if the temperature be subject to little variation, and if there be not too much light. The first operation is to make the husks ferment, which is called *avina*. For that purpose one of the vats is opened, and the husks are put into two others of equal size, taking care to expose them as little as possible to the air, and not to compress them. One vat full of husks ought to fill two, and to occupy a double space after this operation. In some manufactories the husks contained in a vat are distributed into twenty or twenty-five earthen vessels or jars called *oules*, and which are generally sixteen inches in height, fourteen in diameter at the belly, and about twelve at the mouth. When the husks have been put into these vessels, they are covered by putting the lid merely on the opening without pressing it down. The covers are of straw, and made for that purpose. In this state the husks soon heat; and this change may be known by thrusting the hand into them, and by the sour smell which they begin to exhale. The fermentation first takes place at the bottom of the vessel, and gradually ascending extends itself to the whole mass. It proceeds to 30 or 35 degrees of Reaumur.

At the end of three or four days the heat decreases, and at length ceases entirely; and as the manufacturers apprehend the loss of a portion of the vinegar by the natural effect of a heat too much prolonged, they take care after three days fermentation to remove the husks from the fermenting vessels, in order that they may sooner cool. Those who employ vats

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remove them into jars, and thofe who ufe jars put them into others. Befides the lofs of the acetous fpirit, too great heat inclines the mafs at the bottom of the veffel to become mouldy, which renders it unfit for making verdigrife. Some manufacturers, to increafe the effect of the hufks, form them into heaps, which they befprinkle with generous wine before they bring them to ferment.

The fermentation does not always take place at the fame time, nor with the fame energy. Sometimes it commences in twenty-four hours, and fometimes it has not begun at the end of three weeks. The heat fometimes will rife to fuch a height that the hand cannot be kept in the mafs, and that the acetous odour is fo ftrong that one can hardly approach the veffels; while at others the heat is hardly fenfible, and foon vanifhes. There are even inftances of the hufks becoming putrid and mouldy without turning acid. The fermentation is affifted and promoted by raifing the heat of the place by means of chafing-difhes, by covering the veffels with cloths, by fhutting the doors, and by airing the mafs with more care. The differences in the fermentation depend, 1. On the temperature of the air: in fummer the fermentation is fpeedier. 2. On the nature of the hufks: thofe which arife from very faccharine grapes heat more eafily. 3. On the volume of the mafs: a larger mafs ferments fooner, and with more ftrength, than a fmall one. 4. On the contact of the air: the beft aired hufks ferment beft.

At the fame time that the hufks are made to ferment, a preliminary preparation called *defafouga* is given to the plates of copper which are ufed for the firft time. This operation is not employed for thofe which have been already ufed, and confifts in diffolving verdigrife in water in an earthen veffel, and rubbing over each plate with a piece of coarfe linen dipped in this folution. The plates are then immediately placed clofe to each other, and left in that manner to dry. Sometimes the plates are only laid on the

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top of the fermented hufks, or placed under thofe which have been already ufed for caufing the copper to oxydate. It has been obferved, that when the operation called *defafouga* has not been employed, the plates grow black at the firft operation, inftead of becoming green.

When the plates are thus prepared, and the hufks have been brought to ferment, the workmen try whether the latter are proper for the procefs, by placing under them a plate of copper, and leaving it buried there for twenty-four hours. If the plate of copper, after this period, is found covered with a fmooth green cruft, in fuch a manner that none of the metal appears, they are then thought fit for being difpofed in layers with the copper. On the other hand, if drops of water are obferved on the furface of the plates, the plates are faid to *fweat*, and it is concluded that the heat of the hufks has not fufficiently fubfided. They confequently defer making another trial till the next day. When they are affured that the hufks are in a proper ftate, they form them into layers in the following manner:

The plates are all put into a box, which, inftead of having a bottom, is divided in the middle by a wooden grate. The plates difpofed on this grate are fo ftrongly heated by a chafing-difh placed under them, that the woman employed in this labour is fometimes obliged to take them up with a cloth, in order that fhe may not burn her hands. As foon as they have acquired that heat, they are put into the jars in layers with the hufks. Each jar is then clofed with a covering of ftraw, and left to oxydate. This period is called *coüa*, to hatch. Thirty or forty pounds of copper, more or lefs according to the thicknefs of the plates, are put into each jar. At the end of ten, twelve, fifteen, or twenty days, the jar is opened; and if the hufks are white, it is time to take out the plates. The cryftals are then feen detached, and of a filky appearance on their furface. The hufks are thrown back, and the plates are put in what is called *relai*. For that pur-

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pofe they are immediately depofited in a corner of the cellar on fticks ranged on the floor. They are placed in an upright pofition, one leaning againft the other; and at the end of two or three days they are moiftened, by taking them up in handfulls and immerfing them in water in earthen pans. They are depofited quite wet in their former pofition, and left there for feven or eight days; after which they are once or twice immerfed again. This immerfion and drying are renewed fix or eight times, every feven or eight days. As the plates formerly were put into wine, thefe immerfions were called *one wine*, *two wines*, *three wines*, according to the number of times. By this procefs the plates fwell up, the green is nourifhed, and a coat of verdigrife is formed on all their furfaces, which may be eafily detached by fcraping them with a knife.

Each jar furnifhes five or fix pounds of verdigrife at each operation. It is then called frefh verdigrife, moift verdigrife, &c. This verdigrife is fold in that ftate by the manufacturers to people who dry it for foreign exportation. In this firft ftate it is only a pafte, which is carefully pounded in large wooden troughs, and then put into bags of white leather, a foot in height and ten inches in diameter. Thefe bags are expofed to the air or the fun, and are left in that ftate till the verdigrife has acquired the proper degree of drynefs. By this operation it decreafes about fifty per cent., more or lefs according to its primitive ftate. It is faid to ftand proof by the knife, when the point of that inftrument pufhed againft a cake of verdigrife through the fkin cannot penetrate it.

The plates of copper which have been already ufed are again employed for the fame operation, till they are almoft completely confumed. Inftead of heating them artificially, as above mentioned, they are fometimes expofed only to the fun. The fame plates will ferve fometimes for ten years, but they are often worn out in two or three. This, however, depends

depends on the quality of the copper. That which is extremely smooth, well beat, and very compact, is always most esteemed.

Formerly moist verdigrise could not be sold till its quality had been previously ascertained: and for that purpose it was carried to a public warehouse, where it was sold after that point had been determined.

By comparing this process with that described by Montet, it will be found that the changes introduced are much in favour of the new. Formerly the workmen took the stalks of the grapes dried in the sun, and began by immersing them for eight days in *vinasse* (the residuum of the distillation of wine for making brandy). They then suffered the moisture to drain off through a basket, after which they put about four pounds into a jar, and poured over them three or four pints of wine. The stalks were made to imbibe a large portion of the wine, by stirring them strongly with the hand; the jar was then covered, and the stalks were suffered to ferment. The fermentation commenced sooner or later, according to the nature of the wine and the temperature of the air. But after it had once begun, the wine became turbid, and exhaled a strong odour of vinegar. At length the heat decreased, and the stalks were then taken out and the wine was drawn off. When the stalks were a little drained, they were disposed in layers with the plates of copper, and the operation was continued in the same manner as with the husks. When the plates were taken from the jars to be put in *relai*, instead of immersing them in pure water, as is done at present, they were moistened three or four times with sour wine, which was called giving them three or four wines.

It may be easily seen that there is a great saving in the process followed at present, since the manufacturers no longer use wine, which enhanced the price of the verdigrise. Some have condemned, in the new process, the practice of using the copper too soon; but this objection fell to the ground, when

when it was obferved that the verdigrife obtained was in proportion to the copper corroded; and what proves that this method is more advantageous, is, that all the manufacturers have abandoned the old method and adopted the new *.

XII. *On the Method of preparing Tallow Candles with Wooden Wicks. By Profeffor* MEDICUS *of Heidelberg*†.

"FOR feveral years paft tallow candles with wooden wicks have been prepared, in large quantities, by the candle-makers at Munich, and much ufed in that neighbourhood. I have burnt them during the whole winter, and never wifh to ufe any other kind, as they are attended with feveral advantages which common tallow candles do not poffefs. They afford about the fame quantity of light as a wax candle; burn alfo with great fteadinefs and uniformity, and never crackle or run. The candle-makers here keep the method of preparing thefe candles as fecret as they can; but I fhall communicate to the public what I have been able to learn refpecting the procefs.

"The only difference between thefe candles and the common tallow candles is, that the ground work of the wick confifts of a very thin flip of wood, bound round to a confiderable thicknefs with very fine unfpun cotton; but in fuch a manner that the fize of the wick does not much exceed that of the wick of a common candle. The cotton is wound round the wick by the hand; but in general it is done by means of a reel, which I have not yet been able to fee. The thin flips of wood are furnifhed to the candle-makers by the country people, and, if we may judge from

* There are no large manufactories of verdigrife at Montpellier; but each family makes a certain quantity, and the operations are in general performed by women.

† From Riem's *Neue Sammlung Oekonomifcher Schriften*, part xii.

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their appearance, are cut into the proper form by means of a knife, without the application of any machine. They are for the moſt part ſomewhat ſquare, and not completely rounded. The candle-makers often prepare theſe ſlips of wood alſo themſelves, when they have none ready by them, and for that purpoſe uſe pine, willow, and other kinds of wood, though they commonly employ fir. For making theſe candles it is neceſſary to have the pureſt tallow: a pound will be ſufficient to make ſix or ſeven, which coſt 25 kreutzers. The price of common moulded candles with cotton wicks is 22 kreutzers; but as the former burn much longer, they are on the whole cheaper."

Another method of making the wicks is as follows: Take ſhoots of the pine-tree a year old, ſcrape off the bark, and when they are become perfectly dry ſcrape them again all round till they are reduced to the ſize of a ſmall ſtraw. When the above wood cannot be procured, well dried common fir twigs of a year old, and of the ſame ſtrength, may be prepared in the like manner. Theſe rods are then to be rubbed over with wax or tallow, till they are covered with a thin coating of either of theſe ſubſtances; after which they muſt be rolled on a ſmooth table in very fine carded cotton, drawn out to about the length of the rod or candle-mould. Care however muſt be taken that by this rolling no inequalities may ariſe on the rod, and that the cotton may be every where of equal thickneſs, though at the upper part a little more of it may be applied. After this preparation the wick will have acquired the ſize of the barrel of a ſmall quill; and the more accurately the ſize of the wick is proportioned to that of the candle mould, the candles will burn ſo much the better, clearer and longer, as will ſoon be found by a little experience: theſe wicks are then to be placed very exactly in the middle of the mould, and retained in that poſition, and good tallow, freſh if poſſible, previouſly melted with a little water, muſt be poured round them; but even old and rancid tallow will not run, if the wicks be properly made.

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Theſe candles, beſides burning longer than the common ones, have alſo this advantage, that they do not flare, and that they are leſs prejudicial to the eyes of thoſe who are accuſtomed to read or write at night. It is however to be obſerved, that a pair of ſharp ſciſſars muſt be employed for ſnuffing them, and that in performing that operation care muſt be taken not to break or derange the wick.

XIII. *Experiments on the Colouring Matter of Vegetable Juices with the Tungſtic Acid. By Cit.* GUYTON.

IN the ſecond volume of the Philoſophical Magazine, page 126, we laid before our readers a paper by the ſame author on the colouring matter of vegetables, and the action exerciſed on it by metallic ſubſtances and their oxyds; with a new proceſs for obtaining lakes of more intenſe and fixed colours. The preſent may be conſidered as connected with that paper, being, in fact, a detail of the experiments with tungſten, on which the concluſions there given were eſtabliſhed.

" Having ſubjected to experiment an oxyd hitherto little known, I mean the tungſtic oxyd, I ſoon diſcovered that it is one of the moſt valuable ſubſtances for receiving and fixing vegetable colours. I digeſted the juice of the red plum with the white oxyd of tungſten, procured from wolfram, that is to ſay, in the ſtate in which it is conſidered as an acid. The liquor loſt a great deal of its colour, and the metallic oxyd became of a very dark red violet. I decanted the liquor, and boiled it on a new portion of the tungſten. It aſſumed the ſame colour, and the liquor ſtill retained a faint ſhade of red. The liquor being filtered and diluted with water, to defend it from the action of the fire, was treated a third time with freſh oxyd. It then remained colourleſs, and the oxyd of tungſten was found coloured as much as the firſt.

* From Annales de Chimie, No. LXXXIX.

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'It was not now neceſſary to examine the liquor by reagents, for principles which no longer exiſted in it, but to try whether the colour adhering to the oxyd was fixed there in ſuch a manner as to promiſe any advantages to dyeing, or at leaſt to painting. Water boiled a long time, and in ſucceſſion, on this oxyd rather darkened than weakened its colour. This water made no impreſſion upon turnſol paper. Though limpid, it aſſumed, by the addition of the muriatic acid, a ſhade of a pale roſe red colour; and by the addition of pot-aſh, a greeniſh ſhade; but theſe colours totally diſappeared in a few minutes, and could not be made to reappear, by pouring over them freſh acid and freſh alkali. What is more remarkable, the hydro-ſulphure brought back a ſlight tint of violet, which did not diſappear.

"A portion of the coloured oxyd of tungſten was mixed up with gum water, and with a bruſh daubed over a piece of paper. The ſtratum being dry, a thin ſcale of it was detached, in order to be expoſed to the rays of the ſun, and at the end of nine days the colour was neither changed nor weakened. Another ſcale was immerſed in the acetous acid; and being immediately drawn out and dried, it was found to have experienced no change. As little effect was produced upon it by the acetic acid. Lime water applied to it left no ſenſible traces of its effect. The caſe was the ſame with ammonia. A ſolution of ſoap only weakened the tint without changing it. A ſolution of potaſh made a red ſpot, in which the violet ſhade was deſtroyed. A ſolution of the carbonat of potaſh produced an alteration ſtill more ſenſible, the part which had been touched inclining rather to yellow than to red. A ſolution of alum, even concentrated, effected no change. A ſheet of paper, tinged with the colour of this oxyd, being kept for twenty-four hours in a cloſe jar, at the bottom of which was ſome hydro-ſulphure, no change whatever was obſerved. In the laſt place, a ſheet of this paper expoſed to the vapour of the oxygenated muriatic acid, at the ſame time as a like ſheet of paper coloured by turnſol,

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the latter loſt all its colour, while that of the former was not ſenſibly weakened.

"The kind of lake formed by the union of vegetable colouring matter with the oxyd of tungſten may be conſidered, therefore, as having been ſubjected to the ſtrongeſt teſt by the principles moſt deſtructive to colours, and which Berthollet conſiders as the neareſt, in point of ſtrength, to the continued action of the air and light.

"I ſhall paſs over a great number of other experiments leſs direct, or at leaſt leſs concluſive, reſpecting other vegetable colouring matters, and obſerve only that the oxyd of lead, which ſeems to have ſo little action on the red juice of ſtoned fruits, attacks turnſol very ſtrongly; that an infuſion of turnſol, rendered red by the acetous acid, paſſes to a wine colour when treated with iron, and is then in the ſtate of violet juices which become green by alkalies; that the acid juice of yellow fruits, melons for example, gives to the oxyd of tungſten only a faint ſhade of blue, which turns grey by repeated waſhing; and that, on the other hand, this oxyd, digeſted in infuſions of curcuma (turmeric) and turnſol, becomes charged with their colours, and gives them a fixity of which one would not have ſuppoſed them ſuſceptible."

XIV. *Deſcription of an Apparatus in the Teylerian Muſeum for the Combuſtion of Phoſphorus in Oxygen Gas; with Obſervations on the Shining of Phoſphorus in Azot. By* D. VAN MARUM *of Haarlem* *.

HAVING made ſeveral fruitleſs attempts to render a balloon for the combuſtion of phoſphorus perfectly air-tight, according to the method deſcribed by Lavoiſier in his Elements of Chemiſtry, I conſtructed another like that which I employ-

* From *Deſcription de quelques appareils Chimiques*, &c. by Dr. van Marum.

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ed for the compofition of water, and fecured againft the entrance of air in the like manner. This balloon, reprefented by A (Plate II.), has two cocks B C with conical ftoppers, and united to the tubes by the fame means as thofe in the gazometer above mentioned*. Within the balloon is a fmall crucible of platina, *d*, fufpended by two wires of the fame metal from the plate of copper by which the balloon is fhut. The cock B ferves to connect the tube with an air pump, and by thefe means to empty the balloon of atmofpheric air. By the cock C, the oxygen gas, contained in the gazometer G, is introduced; but as this gas ought to be as dry as poffible before it is admitted into the balloon, I have applied between it and the gazometer a glafs cylinder, H, filled with a falt which ftrongly attracts the moifture of the gas. The falt which I found moft effectual in this experiment was that ufed and recommended by Sauffure for drying atmofpheric air †. It is the alkali which remains after the decrepitation of a mixture of equal parts of nitre and crude tartar, and which has been kept at a red heat for an hour.

The falt in the tube H muft not be pulverifed, but divided into fmall fragments, in order that the gas may penetrate through it, and come in contact with a greater portion of its furface. The tubes *i*, *u*, *k*, by which the cylinder H is connected with the gazometer and the balloon, muft be pliable, becaufe it would be too difficult to place the cylinder H in fuch a pofition as to be united with the balloon and gazometer by means of tubes not capable of being bent. I employ pliable tubes of gum elaftic, the ends of which are faftened to the copper pipes fcrewed into the cocks.

Lavoifier kindled the phofphorus in the balloon by a burn-

* For a defcription of the gazometer, or apparatus for producing water by combining hydrogen with oxygen, here referred to, fee the *Philofophical Magazine*, vol. ii. p. 85.

† See De Sauffure's *Effais fur l' Hygrometrie*, p. 25.

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ing glaſs. I have obſerved that phoſphorus wrapt up in a particular manner inflames ſpontaneouſly when the air is rarefied to a certain degree; and I employ the reſult of this obſervation to inflame the phoſphorus in the balloon.

By means of this apparatus I have ſeveral times, both in the courſe of my lectures and on other occaſions, ſhewn the production of the phoſphoric acid by the combuſtion of phoſphorus in oxygen gas, as deſcribed by Lavoiſier in the Memoirs of the Academy of Sciences for the year 1777, (page 65.) In my experiments I have generally burnt ſixty grains of phoſphorus. They have ſhewn that the weight of the phoſphoric acid produced is always nearly equal to that of the phoſphorus burnt, and of the oxygen gas employed. I calculated the reſults by the method deſcribed by Lavoiſier in his Treatiſe of Chemiſtry (vol. ii.); but it is not neceſſary they ſhould be inſerted here, as the compoſition of the phoſphoric acid has been ſufficiently eſtabliſhed by the accurate experiments of Lavoiſier. My object, in deſcribing the apparatus I employed, was merely to enable thoſe who wiſh to repeat the experiments to do ſo by an eaſier method, and with more certainty than according to that propoſed by him. It muſt here be obſerved, that as the phoſphorus, by my proceſs, inflames in rarefied air, there is no danger that the ſudden expanſion of the air, produced by the intenſe heat of the inflamed phoſphorus, will burſt the glaſs; to prevent which, in Lavoiſier's method, requires great caution, as he himſelf has remarked. That the balloon during the combuſtion may be as little heated as poſſible, I ſuffer the air, after the inflammation, to paſs gradually, and in ſmall quantity, into the glaſs globe, and for that reaſon do not open the cock until the flame begins to be extinguiſhed. In this manner the experiment may be performed without any danger.

In the year 1794 I made known, in the thirteenth number of the *Chemiſchen Oeffeningen* of the celebrated Kaſtel-

lyn, my experiments on the combuſtion of phoſphorus in the ſo called vacuum of an air pump. Had profeſſor Göttling, and other German chemiſts who have obſerved phoſphorus to ſhine in azotic gas, paid more attention to what theſe experiments clearly eſtabliſh, they would not have made ſo much noiſe reſpecting a phenomenon which is ſo like the ſhining of phoſphorus before it inflames in air highly rarefied. This ſhining of phoſphorus in an imperfect vacuum, ſhews that the ſmall quantity of oxygen gas contained in atmoſpheric air ſo highly rarefied, is ſtill ſufficient to occaſion that luminous appearance; and as it is well known that it is abſolutely impoſſible to produce azotic gas which does not contain ſome oxygen gas, they might have ſeen by my experiments, that the ſmall quantity of oxygen which muſt have been contained in their azotic gas was ſufficient to produce that light which they obſerved.

I ſhall here only add, that phoſphorus will not ſhine at all in azotic gas which contains no oxygen gas. This I ſhewed, on the 18th of January 1794, in my lectures at the Teylerian Inſtitute. I introduced azotic gas over mercury, and freed it totally from oxygen gas by introducing phoſphorus into it on the point of a bent iron wire, which I paſſed up through the mercury, ſo as to bring the phoſphorus in contact with a piece of ignited iron previouſly introduced into the receiver. All the oxygen gas united itſelf in a moment with the volatilized phoſphorus; and another bit of phoſphorus, which after the cooling of the apparatus I made to riſe through the quickſilver into the azotic gas, which in that manner was freed from all oxygen, did not ſhine. A ſmall bubble of atmoſpheric air was ſufficient to reproduce the ſhining. It was then ſeen diffuſed throughout the whole gas, in the ſame manner as when atmoſpheric air is admitted into an exhauſted receiver in which phoſphorus has ceaſed to be luminous. I ſhewed, in the courſe of the ſame lecture, that phoſphorus does not ſhine in a perfect

vacuum.

vacuum. For this purpofe I caufed the phofphorus to afcend through the quickfilver of a barometer, and it exhibited no light*. In order that this experiment may completely fucceed, you muft employ a barometer, the tube of which has been well freed from atmofpheric air, by boiling the quickfilver in the tube. If you ufe a barometer the quickfilver of which has not been boiled, the fmall quantity of air contained in it will be fufficient to make the phofphorus luminous; but this appearance will be of fhort duration, becaufe the exhaufted fpace of fuch a barometer can contain only a very fmall quantity of oxygen gas.

XV. *A fimple Method of determining the magnifying Power of Telefcopes. By Mr.* S. VARLEY. *Communicated by the Author* †.

THOUGH the fubject on which I wifh to trouble you with a few obfervations muft be well underftood by many of

* It has been already inconteftably proved by experiments, that phofphorus is not luminous in a vacuum. Befides thofe mentioned in the treatife entitled *Ueber das Leuchten des Phofphors im atmofphärifchen Stickgas*, Weimar 1795, p. 58, may be mentioned the following: Hawkfbee approached very near to this difcovery, and to that alfo, made by the author, of phofphorus inflaming in vacuo. He drew fome lines with phofphorus on a piece of paper, and fufpended it within the receiver of an air pump. "After long pumping," fays he, "the luminous appearance was apparently brighter." See the *Philofophical Tranfactions*, vol. xxiv. p. 1865. Lemery mentions experiments of the like kind made by Homberg, in conjunction with M. D'Alence, at Paris, and which correfpond exactly with thofe of Hawkfbee. See his *Cours de Chymie*, Paris 1687, p. 577. Lavoifier found that phofphorus did not inflame, *Memoires de l'Academie*, an. 1777, p. 65; and Profeffors Lempe and Lampadius, that phofphorus was not luminous in the Torricellian vacuum. See Scherer's *Nachträge*, p. 200.

† A "Conftant Reader," in a letter of 23d May, but which did not reach us in time for our laft Number, propofed the following queftion:

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your readers, I have had many opportunities of being convinced that it is not ſo generally known as it ought. Since I firſt ventured to give public lectures on optics, and to explain the various conſtructions of teleſcopes and microſcopes, I have frequently been applied to, to procure thoſe inſtruments for people reſiding at a diſtance from the metropolis, and to prove them before ſending them off. I have alſo been frequently requeſted by thoſe who had purchaſed ſuch inſtruments to give an opinion of their goodneſs, and to determine their magnifying powers; from which I have found that the manufacturers of thoſe inſtruments too generally are in the habit of over-rating their powers *, to the great diſappointment of the buyer, who finds, when too late, that they will not perform what he had been taught to expect from them.

From what I have ſtated, it appeared to me, that a method to determine the magnifying power of teleſcopes, without much trouble or expenſe, and yet ſufficiently exact for moſt purpoſes, might be thought worth a place in your uſeful publication. There are various methods of doing the ſame thing, and each have their particular advantages and diſadvantages: ſome are expenſive; others require long calculations: ſome are attended with much trouble; and others require particular ſituations, which cannot always be commanded. The method I moſtly uſe can be univerſally ap-

" What is the method uſed by opticians to aſcertain the magnifying power of teleſcopes? and how do they *prove* how many times the object is magnified, when ſeen through the ſame?"

The preſent paper, he will ſee, furniſhes a ſatisfactory anſwer. EDIT.

* Even that eminent artiſt Mr. James Short, who rendered himſelf ſo juſtly famous by bringing the reflecting teleſcope to a degree of perfection unknown before his time, too often over-rated the power of his teleſcopes, though not in the ſame ſhameful degree that ſome makers now do. I would not however be underſtood as making this cenſure general: I know one artiſt whoſe reflecting teleſcopes exceed even thoſe of Short, and whoſe teleſcopes I have never once found of leſs magnifying power than they were ſold for; and I hope there are others who are above being guilty of ſo mean an artifice.

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plied, and at almoſt no expenſe; a ſmall ſcale, a pair of compaſſes, and a piece of paper, being all that is neceſſary.—It may be proper, in the firſt place, to ſtate the ſenſe in which I uſe the term *magnifying power of a teleſcope*; for it is differently underſtood by different perſons: alſo to diſtinguiſh between the object itſelf, and the magnified image of the object looked at, as ſeen in the field of the teleſcope. The difference in ſize, between the object viewed with the naked eye and its image as ſeen in the field of the teleſcope, conſtituting the magnifying power of the teleſcope, the queſtion is, How ought this difference to be expreſſed? Should it be expreſſed in a compariſon of their reſpective diameters, areas, or ſolidity? For inſtance, if a piece of paper of three inches ſquare, croſſed each way by three lines, and thus divided into nine ſquares, be placed at a diſtance, and viewed by a teleſcope that cauſes one of thoſe ſquares to appear as large as the whole paper, at the ſame diſtance, appears to the naked eye; if we compare this effect by the difference in diameter, we ſhould ſay, *the inſtrument magnifies three times:* but as one ſquare appears as large, when ſeen through the teleſcope, as the whole nine do to the eye unaſſiſted by that inſtrument, might it not be aſſerted, with equal truth, that it is magnified nine times? The latter appears as reaſonable as the former; but, as in this caſe the paper appears, when viewed by the teleſcope, of the ſame dimenſions as it would do to the naked eye when placed *at one third the diſtance from the obſerver,* it is moſt uſual to ſay, it is magnified three times. Some people, who yet mean the ſame thing, ſay, but improperly, that it appears three times nearer than it really is. Again, if an object at the diſtance of 100 yards appears by the teleſcope as large and diſtinct as it would do to the naked eye at the diſtance of one yard, it is ſaid to be magnified one hundred times; and it is to be underſtood in this ſenſe in the following experiments:—By a teleſcope of the laſt mentioned power, a printed paper, at the

diſtance of 100 yards, can be as diſtinctly read as it could by the eye at the diſtance of one yard; and it is owing to this aſtoniſhing property that the heavenly bodies can be contemplated as though they were only the one, two, three, four, or five hundredth part the diſtance that they are in reality.

The planets, for inſtance, have nothing in their appearance to the naked eye, that would engage our particular attention, or enable us to diſtinguiſh them from the fixed ſtars, except their being obſerved to change their places amongſt the fixed ſtars, ſometimes moving from weſt to eaſt, then for a ſeaſon remaining ſtationary, having no *apparent* motion at all; then again, to have a little motion from eaſt to weſt, which keeps increaſing a certain time, when it again decreaſes, until they once more become ſtationary. They were thus diſtinguiſhed from the fixed ſtars long before teleſcopes were invented, and on this account were called erratics, or wandering ſtars, their real and regular motions and periods being at that time unknown. But, by the aſſiſtance of the teleſcope, in each of them may be obſerved what excites aſtoniſhment and claims our particular attention, eſpecially if the inſtruments are good of their kind, and magnify from two to four hundred times. In viewing Saturn, the ſloweſt, and now known to be the moſt diſtant planet of all, except the Georgium Sidus, inſtead of a pale ſolitary wanderer, he is found to be accompanied with ſix or ſeven moons, revolving round him at ſtated, fixed, and regular periods, and to be encompaſſed with (a greater wonder ſtill) a double ring, no where touching him, but ſuſpended ſo as to have its inſide edge every where twenty-one thouſand miles from his body. The planet Jupiter is obſerved to have ſeveral belts that appear, though upon his body, as having ſeveral ſpots, by which his diurnal motion on his axis is determined to be much quicker than that of our earth, being performed in about eight hours, notwithſtanding he is ſo much larger.

He is alſo ſeen to be accompanied with four moons, or ſatellites, revolving in certain periods: even their eclipſes, which afford an excellent method for determining the longitude of places on our earth, can be diſtinctly ſeen. Mars is obſerved to have ſome ſpots near one of his poles, by which he is known to have a diurnal rotation round his axis. The beautiful planet Venus, that now adorns our evening ſky, is obſerved to wax and wane like our moon; ſometimes being merely a creſcent, then horned like the moon only a few days old, then gibbous, afterwards full; exhibiting different phaſes like our moon, and thus affording an inconteſtible proof of the Newtonian ſyſtem of aſtronomy, now univerſally adopted by men of ſcience in every part of the world *.

The planet Mercury, though but ſeldom ſeen, yet deſerves our attention, as he more frequently than Venus paſſes betwixt the ſun and us, appearing like a patch upon the diſc of the ſun, and thus, to thoſe that know how to avail themſelves of theſe phenomena, gives additional proof of the truth of the preſent ſyſtem. The ſplendid face of our moon, in her various phaſes, offers ſo many ſimilarities to the earth which we inhabit, as leave but little room to doubt ſhe is deſtined for the ſame grand end, an habitation for in-

* The truth of this ſyſtem has been proved by innumerable obſervations made with this excellent inſtrument, by men every way qualified to judge, who with unwearied diligence, and without any bias or motive whatever but a ſtrong deſire to ſearch out the truth, have examined and proved every part of it, and fixed it upon too ſtrong a baſis to be overturned or refuted by the ignorant or intereſted, who pretend to do ſo without poſſeſſing one ſingle qualification to enable them to form a proper judgment in this matter, or a ſingle pretenſion but what is founded in the groſſeſt ignorance, accompanied with the moſt conſummate aſſurance. But enough of this at preſent. Perhaps at a future opportunity I may offer ſome remarks upon, and throw together ſome of the leading features of the Newtonian ſyſtem, for the ſake of thoſe who, for want of better information, are daily duped out of their money by the contemptible jargon of even the moſt ignorant and ſtupid of mankind.

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telligent beings; thus anſwering the double purpoſe of an additional light to us, and a convenient habitation for others; while ſhe, in return, receives a like benefit from the earth, which anſwers the purpoſe of a luminary to her. She is ſeen to have broad ſeas, bounded with rocky ſhores; extended continents, diverſified with hill and dale; deep valleys and towering mountains; mountains, whoſe extended ſhadows can be traced, and as diſtinctly ſeen, as the ſhadow of a ſun-dial; and, lately diſcovered (owing to the great improvements made in teleſcopes), volcanic or burning mountains.

An eaſy method to determine the magnifying power of thoſe inſtruments, whoſe excellence it is to have made us intimately acquainted with the various phenomena above mentioned, and which give us ſources of enjoyment from the contemplation of diſtant terreſtrial objects, of which our forefathers had no conception, cannot but be acceptable to many, eſpecially to thoſe who have not the opportunity of employing the more expenſive proceſſes that are reſorted to for the ſame end.

The ſimpleſt method is, to meaſure the emergent pencil or cone of light, as it appears in the eye-hole of the teleſcope, and to divide the diameter of the aperture of the object-glaſs, if it is an achromatic, or of the great milla, if a reflector, by the diameter of this emergent pencil, and it will give the magnifying power. For this purpoſe, I take a piece of thin writing paper, a little more than two inches in length, and about half an inch in breadth; I draw with a good pen, or other proper inſtrument, the line *a*, *b*, fig. 28, (Plate I.) and then, with a pair of good dividers, I take from a ſcale one tenth of an inch, which I ſet off from *b* to *c*, and then, with the ſame extent, divide the line *a*, *b*, into 20 equal parts, making viſible marks or punctures at each diviſion. I then draw the line *a*, *c*, and make the diviſions 1, 2, 3, 4, &c. to 10, at every other diviſion or point made with the dividers, and put a little ſweet oil upon the paper

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to make it more tranſparent. I ſometimes omit making the lines 1, 2, 3, &c. and content myſelf with numbering every ſecond hole made by the dividers; the numbers are to expreſs, in hundredths of an inch, the diſtance of the lines *a*, *b*, and *a*, *c*, at thoſe points where they are placed. Being thus provided, I adjuſt the teleſcope to diſtinct viſion, by looking at ſome diſtant object, and then take off the eye-hole, if the teleſcope will admit it to come off, which reflectors always do, but the night eye-pieces of achromatics do not without taking away the firſt glaſs alſo. Having now directed the teleſcope to the open day-light, I take the divided paper in one hand, and a hand magnifier to view it with in the other, and apply the paper to meaſure the diameter of the bright pencil of light as it emerges from the eye-glaſs, and at that diſtance where it appears leaſt in diameter, as at *c*, fig. 29, where the rays of light, having paſſed the lens *a*, converging to *c*, there croſs each other, and proceed diverging to *d* and *e*: this place, where the paper is to be applied, will be eaſily known by obſerving, with your hand magnifier, (which ſhould be of an inch, or at moſt an inch and half focus,) where the bright ſpot, as at *d*, fig. 28, appears diſtinct and well defined at the edges, and the filaments of the paper diſtinctly ſeen at the ſame time. A place on the paper may be found, where the bright ſpot will juſt fill up the ſpace between the lines *a*, *b*, and *a*, *c*. Suppoſe this takes place at *d*, where it will be extremely near the third diviſion, and of courſe three hundredths of an inch in diameter; and ſuppoſe your teleſcope to be a 30-inch achromatic, and the diameter of the object glaſs two inches and one tenth, or 210 ſuch diviſions; theſe, divided by three, will give 70 for the magnifying power of your inſtrument. Suppoſe, with a different eye-piece, the pencil of light only occupied the ſpace between the lines at *i*, it would be one and one half of thoſe diviſions: in this caſe divide 210, the hundredths of an inch contained in the diameter of your object glaſs, by 1·5, and it

it will give 140 for the magnifying power. Again, ſuppoſe with ſome other eye-piece the beam of light fills the lines at the fourth diviſion: divide your 210 by 4, and it will give 52·5 or 52, for the power. If your paper be oiled with good linſeed oil that has been boiled, ſuch as the painters call drying oil, it will laſt for many years, and have this advantage over the inſtruments made for this purpoſe which are ſold for 3l. 3s. that, as the ſcrew for receiving the dark glaſs projects beyond the place where the paper ſhould be held, the paper will bend, and thus can be introduced into its proper ſituation without producing any ſenſible error. Another method, which I ſometimes uſe in confirmation of the former, and which cannot fail to produce full conviction on the mind, is as follows: I meaſure the ſpace occupied by a number of the courſes of brick in ſome modern brick building, which, upon an average, will be found to have eight courſes in two feet: hence each courſe is three inches. I then cut a piece of paper three inches in height, and nearly of the length of a brick, which is about nine inches, ſo that it may repreſent a brick, but with this advantage, that its edges will be much better defined; and fixing the paper againſt the wall (ſee fig. 27), place the teleſcope to be examined at the diſtance of 50 or 100 yards from the wall; and looking through the teleſcope at the paper with one eye, and at the ſame time with the other eye looking paſt the teleſcope, I obſerve what extent of wall the magnified image of the paper appears to cover. I then count the courſes of bricks in that extent, which gives the magnifying power of the teleſcope. This method will appear a little difficult at firſt, but, by a few trials, will become ſo familiar, that the paper, as ſeen by the teleſcope, may be eaſily compared with the bricks ſeen by the other eye.

I intended to have added ſeveral other obſervations on ſubjects nearly related to the above; but having exceeded the

the bounds I propofed to myfelf, muft referve them for a future number, if you fhould think fubjects of this nature worth infertion*.

XVI. *Sixth Communication from Dr.* THORNTON, *Phyfician to the General Difpenfary, &c. &c. relative to Pneumatic Medicine.*

A REMARKABLE CASE OF PULMONARY DISEASE CURED BY THE INHALATION OF HYDRO-AZOTE.

MR. GREGORY, M. P. of Berner's-ftreet, who had been long refident in India, laboured for feveral months under all the fymptoms of phthifis pulmonalis. He expectorated a quantity of thick, opaque, and yellowifh matter which funk in water, had difturbed nights, was greatly wafted, and his breathing was fhort and interrupted. He took by my order (which was executed by Mr. Leaton, a very ingenious apothecary and able chemift, who lives in Bridge-ftreet, Weftminfter) from four to fix quarts hydro-azote daily, mixed with twelve of atmofpheric air, and at the fame time had a mixture of myrrh and bark, with opiates occafionally; and under this treatment the cough was foon diminifhed, and in fix weeks the patient was reftored to health, and has continued free from every complaint thefe eight months; even a cold now paffes off without exciting any fymptoms of alarm. Dr. Hooper, of the Mary-le-bone Infirmary, and feveral others of the Faculty, who have feen this cafe, think that it may be produced as a very ftrong argument in favour of the pneumatic practice.

* Subjects handled in the familiar and popular manner which Mr. Varley fo fuccefsfully follows, cannot fail to be ufeful, not only to the cafual examiner, but to men of fcience; and we fhall be happy to receive his communications as often as his other avocations will allow. EDIT.

Obfervation.

Obſervation.

The hydro-azote is made by burning æther under a bell-glaſs, when the oxygen unites with the hydrogen and forms water, and the reſidue is azotic air; a ſpecies of heavy, inflammable, or hydrogen air, and ſome æther in the ſtate of vapour, and a ſmall proportion of fixed air. I have myſelf inhaled ten quarts of this pure, and the pulſe has ſunk from eighty to ſeventy beats in a minute, and continued ſo for a quarter of an hour or more. It is very grateful to the lungs; and I flatter myſelf, that this new ſpecies of air, firſt employed by me, may prove hereafter a valuable acquiſition to the *ars medendi*. As we brace the conſtitution with tonic medicines, thereis danger of local inflammation, which this appears to obviate; or, has the hydro-azote any peculiar healing quality?

XVII. *Biographical Memoirs of M. de* Saussure. *By A. P.* Decandolle †.

Horace Benedict de Saussure was born at Geneva in 1740. His father, an intelligent farmer, to whom we are indebted for ſome memoirs relating to rural economy, reſided at Conches, a place ſituated on the banks of the Arve, at the diſtance of half a league from Geneva; and this country life, added to an active education, expanded no doubt in young De Sauſſure that phyſical ſtrength ſo neceſſary to the naturaliſt who devotes himſelf to travel. He repaired daily to town to enjoy the advantage of public inſtruction; and as he lived at the bottom of Saleve, a mountain which he has ſince rendered celebrated, he amuſed himſelf frequently with aſcending its ſteep and rugged ſides. Being thus ſurrounded by the phenomena of nature, and at the ſame time aided by ſtudy, he conceived a taſte for natural hiſtory, and avoided the error both of the learned, who form theories without

† From *Decade Philoſophique*, No. XV.

having

having been out of their cloſets, and of thoſe farmers who, living too near to nature, are incapable of admiring her beauties.

His earlieſt paſſion was botany: a variegated ſoil, abundant in plants of different kinds, invites the inhabitant of the banks of the Leman to cultivate that agreeable ſcience. This taſte produced an intimacy between De Sauſſure and the great Haller. He paid him a viſit in the year 1764, during his retreat to Bex; and he relates in his travels how much he admired that aſtoniſhing man, who excelled in every part of the natural ſciences. De Sauſſure was induced alſo to ſtudy the vegetable kingdom, by his connexion with Ch. Bonnet, who had married his aunt, and who ſoon ſet a juſt value on the riſing talents of his nephew. Bonnet was then employed on the leaves of plants. De Sauſſure ſtudied theſe organs of vegetables alſo, and he publiſhed the reſult of his reſearches, under the title of *Obſervations on the bark of leaves*. This ſmall work, which appeared ſoon after the year 1760, contains new obſervations on the epidermis of leaves, and in particular on the miliary glands by which they are covered*.

About that period the place of profeſſor of philoſophy falling vacant, it was conferred upon De Sauſſure, who was then only twenty-one years of age. Experience proves, that if premature rewards extinguiſh the zeal of thoſe who labour merely for themſelves, they, on the contrary, ſtrengthen it in thoſe who labour only for truth. At that time the two profeſſors of philoſophy at Geneva taught phyſics and logic alternately. De Sauſſure diſcharged this double taſk with equal ſucceſs. He gave to his courſe of logic a practical, and, as one may ſay, experimental turn; and his method of teaching, which began by ſtudying the ſenſes to arrive at the general laws of the underſtanding, announced already an able obſerver of nature.

Phyſics however were the part for which he had the greateſt taſte, and which conducted him to the ſtudy of chemiſtry

* He had reſumed this ſubject eighteen months before his death.

and mineralogy. He then began his travels through the mountains; not now to examine their vegetable productions, but to ſtudy the mountains themſelves, either in the ſtones of which they are compoſed, or the diſpoſition of their maſſes. Geology, a ſcience which was then ſcarcely in exiſtence, added charms to his numerous excurſions through the Alps; and it was then that the talents of the great philoſopher were really diſplayed. During the firſt fifteen or twenty years of his profeſſorſhip, he employed himſelf by turns in diſcharging the duties of his office, and in traverſing the different mountains in the neighbourhood of Geneva. He even extended his excurſions on one ſide as far as the banks of the Rhine, and on the other to Piedmont. At the ſame time he undertook a journey to Auvergne to examine there the extinguiſhed volcanoes, and another to Paris, England, and Holland. After that he viſited Italy, and even Sicily. Theſe were not mere journeys for the purpoſe of reaching any particular place. He undertook them only with a view of ſtudying nature; never travelled but ſurrounded by every inſtrument that could be of uſe to him, and never ſet out until he had drawn up a plan of the experiments and obſervations he intended to make. He often ſays in his works, that he had found this method exceedingly uſeful.

In the year 1779 he publiſhed the firſt volume of his *Travels through the Alps*, which contains a minute deſcription of the environs of Geneva, and an excurſion as far as Chamouni, a village at the bottom of Mont-Blanc. Philoſophers will read there with pleaſure the deſcription of his *magnetometer*. The more he examined mountains, the more was he ſenſible of the importance of mineralogy. To ſtudy it with advantage, he learned the German language; and it may be ſeen, in the laſt volumes of his Travels, how much new mineralogical knowledge he had acquired.

Amidſt his numerous excurſions through the Alps, and at the time of the political troubles of Geneva in 1782, he found means to make his beautiful experiments on hygrometry, which

which he publiſhed in 1783 under the title of *Eſſays on Hygrometry*. This work, the beſt that ever came from his pen, eſtabliſhed fully his reputation as a philoſopher. We are indebted to him alſo for the invention of a new hygrometer. Deluc had already invented his whalebone hygrometer; and on that account there aroſe between him and De Sauſſure a ſort of conteſt, which degenerated into a pretty violent diſpute.

In the year 1786 De Sauſſure reſigned the profeſſor's chair, which he had filled for about twenty-five years, to his pupil and fellow-labourer Pictet, who diſcharged with reputation the duties of an office rendered more difficult by ſucceeding ſo eminent a philoſopher.

When De Sauſſure was invited by the ſtate to take a ſhare in the public education, he made it one of the ſubjects of his meditations, and preſented the plan of a reform in the education of Geneva, the tendency of which was, to make young people early acquainted with the natural ſciences and mathematics. He even wiſhed that their phyſical education ſhould not be neglected, and with that view propoſed gymnaſtic exerciſes. This plan, which excited much attention in a city where every one is convinced of the importance of education, found admirers and partiſans; but the poverty of its pecuniary reſources was an obſtacle to every important innovation. It was beſides feared that, by altering eſtabliſhed forms, they might loſe the ſubſtance, and that things might be changed for the worſe. The Geneveſe were attached to their old ſyſtem of education; and they had reaſon to be ſo, becauſe it had not only proved the means of diffuſing knowledge generally amongſt them, but had called forth the talents of ſeveral eminent mathematicians* and philoſophers†.

But De Sauſſure's attention was not confined to public edu-

* Abauzit, Cramer, Lhuilier, J. Trembley, &c.

† Jalabert, A. Trembley, Bonnet, Leſage, Deluc, Senebier, Prévoſt, Pictet, and De Sauſſure himſelf.

cation alone. He ſuperintended himſelf the education of his two ſons and a daughter, who have ſhewn themſelves worthy of ſuch an inſtructor. His daughter to the charms of her ſex unites an extenſive knowledge of the natural ſciences; and his eldeſt ſon has already made himſelf known by his phyſical and chemical labours.

The ſecond volume of his Travels was publiſhed in 1786. It contains a deſcription of the Alps around Mont-Blanc, which the author conſiders as a mineralogiſt, a geologiſt, and a philoſopher. He gives alſo ſome intereſting experiments on electricity, and a deſcription of his electrometer, the moſt perfect we have. We are indebted to him alſo for ſeveral inſtruments of meaſurement, ſuch as his *cyanometer*, deſtined to meaſure the degree of the blueneſs of the heavens, which varies according to the elevation of the obſerver: his *diaphanometer*, or inſtrument for meaſuring the tranſparency of the atmoſphere; and his *anemometer*, which, by means of a kind of balance, weighs the force of the wind.

Some years after the publication of the ſecond volume of his Travels, De Sauſſure was admitted as a foreign aſſociate of the Academy of Sciences of Paris; and Geneva could then boaſt of having two of its citizens in that claſs, which conſiſted only of ſeven members. De Sauſſure not only did honour to his country: he loved and ſerved it. He was the founder of the Society of Arts, to which Geneva is indebted for the high ſtate of proſperity it has attained within the laſt thirty years. He preſided over that ſociety till the laſt moment of his life, and one of his fondeſt wiſhes was the preſervation of this uſeful eſtabliſhment.

In conſequence of M. de Sauſſure's fatiguing labours in the Council of Two Hundred, of which he was a member, and afterwards in the National Aſſembly, his health began to be deranged, and in 1794 he was almoſt deprived of the total uſe of his limbs by a ſtroke of the palſy. However painful his condition then might be, his mind ſtill preſerved its

activity;

activity; and after that accident he revifed the two laft volumes of his Travels, which appeared in 1796. They contain an account of his excurfions to the mountains of Piedmont and Swifferland, and in particular of his journey to the fummit of Mont-Blanc. Thefe volumes, inftead of exhibiting any marks of his malady, prefent an enormous mafs of new facts and obfervations of the utmoft importance to phyfics.

He rendered alfo an important fervice to that fcience by publifhing the *Agenda**, which terminate his fourth volume, and in which that great man, furviving himfelf, conducts the young naturalift through the middle of mountains, and teaches him the method of obferving them with advantage. Thefe *Agenda* are a proof of his genius, and of the ftrength of mind which he retained amidft his fufferings. It was alfo during his illnefs that he publifhed *Obfervations on the fufibility of ftones by the blow-pipe*, and that he directed the experiments made on the height of the bed of the Arve *. Having gone for the fake of his health to the baths of Plombiers, he ftill obferved the mountains at a diftance, and caufed to be brought to him fpecimens of the ftrata which he perceived in the fteepeft rocks. He had announced that he would conclude his Travels with fome ideas on the primitive ftate of the earth; but the more he acquired new facts, and the more he meditated on the fubject, the more uncertain did his opinions become in regard to thofe grand revolutions which preceded the prefent epoch. In general he was a Neptunian; that is to fay, afcribed all the revolutions of our globe to water. He admitted the poffibility of the mountains having been thrown up by elaftic fluids difengaged from the cavities of the earth.

Though the ftate of his health began gradually to become

* Part of thefe *Agenda* have been already given in the *Philofophical Magazine*: the reft will be given in the fubfequent numbers. EDIT.

* His memoirs on thefe fubjects were inferted in the *Journal de Phyfique*.

 worfe,

worfe, he ftill entertained hopes of recovery; and the French government having appointed him profeffor of philofophy at the Special School of Paris, he did not defpair of being one day able to fill that office: but his ftrength was exhaufted, a general languor fucceeded the vigour he had always enjoyed, his flow and embarraffed pronunciation no longer correfponded with the vivacity of his mind, and formed a melancholy contraft with the pleafantnefs by which he had been formerly diftinguifhed. It was a painful fpectacle to fee this great man reduced thus to imbecility at an age when meditation is beneficial, and when he ought at leaft to have enjoyed the fruits of his reputation and labours.

In vain did he try, for the re-eftablifhment of his health, all the remedies which medicine enlightened by the phyfical fciences could afford—all affiftance was ufelefs. The vital power quitted him with flow and painful fteps. Towards the beginning of autumn laft year his decay became more vifible, his mind loft all its activity, and on the 22d of March 1799 he terminated his brilliant career, at the age of 59, lamented by a family to whom he was dear—by a country to which he had done honour—and by Europe, the knowledge of which he had extended.

XVIII. *Letter from Dr.* Carmichael Smyth *to the Editor of the Philofophical Magazine.*

SIR,

OBSERVING in your Magazine of laft month an article in which Mr. Cruickfhank has corrected a miftake I had fallen into in relating an experiment of his on variolous matter; I have only to fay, that had this gentleman informed me of this circumftance, I certainly would have faved him the trouble he has taken. As for the way in which the miftake originated, although it could be eafily explained; yet, as the recollection of this gentleman and of his friend

friend Dr. Rollo, in regard to the converſation that paſſed at the time, differ ſomewhat from mine, I chooſe to avoid the diſcuſſion of a queſtion that reſts on the memory of the parties.

Beſides, the miſtake once corrected, the public have no farther intereſt in it, and the perſon concerned almoſt as little. It did not in the leaſt affect the merit of the experiment, whether it was made in one way or the other; and it is equally evident that I could have no object in view, or purpoſe to ſerve, in miſrepreſenting it.

I have the honour to be, Sir, your obedient ſervant,

JAMES CARMICHAEL SMYTH.

Charlotte Street, Bloomſbury,
June 16, 1799.

INTELLIGENCE,

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

DENMARK.

THE Society of Agriculture at Copenhagen has propoſed three prizes, to be paid by the admiralty, one of five hundred, one of a hundred, and one of fifty rix-dollars, for the beſt paper on the rearing of timber proper for ſhip-building. The points reſpecting which the ſociety wiſhes to be informed are: 1. What ſoil is beſt ſuited to the different kinds of wood, and what care is required in the cultivation of them? 2. Can the neceſſary form and degree of flexion be by any means given to the timber without injuring it? 3. What is the proper time for cutting the trees? 4. Is it

beneficial to bark the trees before they are cut, and in what manner is that operation to be performed? The answers to these questions must, as far as possible, be confirmed by experiments. If the author supports any of his observations on the authority of foreign publications, he must be careful to refer to them in a marginal note. The papers may be written in Danish, German, French or English, and must be transmitted to the Society before the month of October next.

GERMANY.

The following question in economics has been proposed by the Royal Society of Gottingen: Has inoculation of the small-pox in sheep been attended with any real utility? does it secure them against infection? and what rules are to be observed respecting it? The Society wishes that the answers to this question may be confirmed by undoubted experiments. The prize is twelve ducats, and the papers must be transmitted to the Society before the month of September.

PROCEEDINGS OF THE INSTITUTE OF CAIRO.

Frimaire 1, *Seventh Year.* [*Nov.* 22, 1798.]

A memoir by C. Corancez was read, in which the author examined the means of remedying the alteration in the movement of watches, occasioned by changes of temperature. He proposed, for this purpose, that the balance should be composed of different metals; and he examined by calculation what ought to be the form of the parts to render the *vis inertiæ* constant, while the oscillating mass dilates or contracts.

C. Savigny read a memoir on the natural history of Egypt, with an enumeration of the different species of animals hitherto observed in Lower Egypt, and particularly insects. He pointed out also some of the causes which may have contributed to reduce the number of these species.

C. Sucy proposed the appointment of a commission for the purpose of collecting information from the inhabitants of countries adjacent to Egypt, which might then be at Cairo,

Cairo, and in particular reſpecting the courſe of the upper part of the Nile, and the natural and civil hiſtory of Abyſſinia.

Frimaire 6. [*November* 27.]

C. Levaſſeur, director of the artillery and marine at Alexandria, tranſmitted to the Inſtitute a memoir on the different proceſſes proper to correct certain faults in various kinds of iron and ſteel.

C. Say propoſed that different pieces of coin, found in digging among the ruins of Bellecis, ſhould be depoſited in the library.

Frimaire 11. [*December* 2.]

C. Hybert, captain of the 85th demi-brigade, ſent to the Inſtitute an allegorical drawing made in honour of General Buonaparte.

C. Deſgenettes, in name of a commiſſion, gave in a report on the ophthalmy preſented by C. Larreſt, ſurgeon general to the army.

C. Monge read ſome obſervations he had made on the phenomena of capillary tubes.

Frimaire 16. [*December* 7.]

C. Balzac, architect, preſented a poetical piece on the relative ſituation of the French in Egypt.

C. Berthollet read a paper on dyeing cotton and linen with the carthamus. Egypt ſupplies Europe with the carthamus, and it is uſed there for dyeing ſilk. In Egypt it is employed in the dyeing of cotton, and the proceſs conſiſts, 1. In ſeparating, by means of a water a little alkaline, the yellow part from the red ſubſtance. 2. In incorporating the alkali under the grinding-ſtone with the carthamus. 3. In keeping the heat of the bath at the temperature of from 30 to 40 degrees [of Reaumur, we ſuppoſe].

C. Levaſſeur's memoir on correcting the faults in certain kinds of iron and ſteel having been referred to a commiſſion, a report on that ſubject was read by C. Deſcoſtils. Iron which breaks when forged cold is a mixture of two metals, one

one of which is more fusible than the other; and it cannot be forged but when both metals are softened by the action of heat, or when they are both cold. C. Levasseur pointed out therefore several methods of correcting cold short iron, whether its defect arises from the steely quality it has retained, or from the presence of phosphorus. The means employed by the author to remedy the too great hardness of steel and steelified iron, were by subjecting them to cementation with oxygenated substances.

C. Buonaparte communicated to the Institute an account of the number of persons, inhabitants of Cairo, who had died in the course of a hundred days. The number was 1076, comprehending only Mussulmans.

C. Monge announced, that it appeared from observations made lately at Cairo by C. Beauchamp, that the declination of the magnetic needle was $12\frac{1}{2}°$.

Frimaire 21. [*December* 12.]

C. Regnier presented to the Institute, from his brother General Regnier, specimens of rock detached from a hill called Djebel Nabo. C. Berthollet and Descostils were charged to examine the nature of these specimens.

C. Frank, physician, transmitted to the Institute a paper respecting the art of the ophiogenes. The author had frequent opportunities of observing, in different parts of Egypt, the confidence and address with which certain inhabitants of that country handled serpents; and his remarks on this subject will serve to illustrate the accounts given by travellers of the arts employed by these people.

Frimaire 26. [*December* 17.]

C. Fourier presented to the Institute a second part of a treatise entitled *Researches in regard to Mechanics in general.*

The secretary read a poetical composition on the death of a young French soldier, who had been taken by the Arabs soon after the arrival of the army in Egypt.

C. Ripault,

C. Ripault, librarian, presented a memoir, entitled *Researches respecting the Oasis.*

ROYAL SOCIETY OF LONDON.

Since our last report papers on the following subjects have been read at the meetings of this learned body:—

On a new Principle in Tanning, by George Biggin, Esq. From the experiments adduced in this paper it appears, that elm bark is the least powerful of any, and that oak bark in winter is not so powerful as in spring in the proportion of 30 to 128.

On Lime employed for manure by Smythson Tennant, Esq. This paper contains much useful practical information respecting the effects produced by different kinds of lime-stones. One kind, found near Doncaster, proves highly detrimental to the land on which it is laid, however sparingly, so as to destroy almost entirely all vegetation: this mischievous property is found to be owing to the presence of a portion of magnesia. Near Ferry-bridge, on the other hand, a lime-stone is found which proves highly fertilizing applied in any quantity. This paper is accompanied with a table of different pernicious lime-stones found in various parts of the kingdom.

The reading of a paper on the Decomposition of Borax by Professor Crell, and an interesting one on Shells and Bones, by Charles Hatchet, Esq. terminated the session, which was closed on the 13th instant.

AEROSTATION.

Several of the foreign journals have announced an invention of Professor Danzel for directing an air balloon through the atmosphere. The following is a short account of the method. M. Danzel has constructed two cylinders or axles, to the ends of which are fixed, in the form of a cross, four sails or oars, moveable at the point of their insertion into the cylinder, in such a manner that, when made to move round by means of a handle, the eight oars, like the cogs of a water-

mill wheel, prefent in fucceffion to the air fometimes their flat fide and fometimes their edge.

To caufe each oar to turn back on itfelf about the fourth part of a circle, M. Danzel has not only left fufficient play at the point where the ftick of each oar is inferted in the cylinder, but has placed the ftick in fuch a manner that the air itfelf makes the oar fall back, at each turn, with the neceffary velocity and precifion. It muft here be underftood that the two cylinders, armed with their four oars or fails, are deftined to occupy one each fide of the balloon, four oars on each fide.

It is well known that aëroftation has a refemblance to flying or fwimming rather than to failing, fince every aëroftat is immerfed in the air as a bird, or as a fifh is immerfed in water; whereas the effort of a veffel is divided between two elements, one of which, the water, gives it a great point of fupport, and the other, the air, is very eafy to be divided. But the aëroftat being totally immerfed in the air, it was neceffary to find out a movement which, though circular, fhould not deftroy at each half turn the effect of the preceding one; for, the refiftance being equal in the whole circumference, it is evident that the fupport muft be diminifhed or even annulled, if poffible, in one half of the circle, and be retained full and perfect in the other. This M. Danzel has effected, by prefenting to the air fometimes the edge and fometimes the flat part of the fails on each fide, in turns and with great regularity. The refult is, that during a continued rotation each cylinder produces a ftrong current of air behind, and rarefaction before; and this current, which continues without intermiffion, is very fenfible. It is evident then that a body fufpended in air at reft, if thefe two cylinders are attached to it, muft advance towards the rar. fi.d fpace occafioned by their rotation, and produce a continual current of air behind it.

The cogged wheels of water mills being half in the water and half in air, the co_s may be immoveable, becaufe at each

each half turn the force of the water overcomes the reſiſtance of the air, in the proportion of a thouſand to one; but if the wheel with its immoveable cogs were entirely immerſed in a current of water, it is evident that it would not turn at all, becauſe the water would make two efforts in oppoſite directions on the upper and lower cogs. If we now ſuppoſe ſuch a cogged wheel totally immerſed in ſtagnant water, and that by means of any power it is made to turn on itſelf, it will only agitate the water without producing a current; and if it be free to advance or recede, it will do neither. But if the cogs are rendered moveable by M. Danzel's method, in ſuch a manner that the wheel preſents alternately at each half turn the flat ſide and the edge, it will neceſſarily advance, and occaſion a current of water behind it.

NAVIGATION.

M. Danzel has invented alſo an hydraulic machine for making a ſhip or boat advance during a calm, and even againſt a current. The mechaniſm of this machine is extremely ſimple; and if we did not know that the ſimpleſt means are often diſcovered the lateſt, we might be ſurpriſed that it ſhould not have been found out before. It conſiſts of a long pole, to the anterior extremity of which an apparatus, ſhaped like a drawer without back or front, is attached in ſuch a manner that when puſhed forwards it folds itſelf back under the pole, to which it as it were adheres, and preſents to the water the thin cutting ſurface of its three edges, viz. of the bottom and two ſides, which can neither oppoſe to the water a reſiſtance capable of preventing the pole from penetrating farther, or of making the ſhip recede.

When the pole, which is puſhed forwards from the veſſel, has attained to its full reach, the drawer as ſoon as the pole is pulled back aſſumes a vertical poſition, and preſents to the water its whole cavity. By theſe means it embraces a column of water, which, without finding means to eſcape, preſſes on

a ſurface much larger than that of a common oar, and keeps the drawer immoveable ; ſo that thoſe who draw the pole towards them, inſtead of making the veſſel to recede, cauſe it to advance. This machine, which may be multiplied more conveniently than oars, has this viſible advantage over the latter, that it oppoſes to the water a reſiſtance infinitely ſuperior, while the paſſive re-action of this reſiſtance renders the labour of the mariners leſs laborious and more effectual.

METEOROLOGY.

The following note has been lately publiſhed by Delalande in one of the French Journals :

" M. Von Zach, director of the obſervatory of Gotha, the moſt celebrated and moſt uſeful aſtronomer of Germany, and whom I viſited laſt ſummer, informs me, in one of his letters, that on the 25th of December he ſaw the thermometer at 21° Fahr. below 0°. In the duchy of Wirtemberg it was at 24°, at Augſbourg 25°, at Manheim 19°, at Vienna 18°, at Amſterdam 16°, at Dreſden 14° as at Paris; but at Copenhagen, which is much farther north, it was only at 10 degrees. Thus the cauſe of this great cold did not come from the north, but probably from Siberia and Tartary. I am accuſed of having predicted that the winter would be *moderate*. This is not correct. Some weak perſon had ſaid, in one of the Journals, that every 400 years the winter was ſevere, and that the laſt one correſponded with that period. I replied, that the period of 400 years had no foundation ; and that, if there were any probable means of foretelling any thing, it would be by the period of 18 years : it has ſucceeded ſometimes. M. Toaldo aſſerts, that in Italy it ſucceeds always ; and it was this which promiſed us a moderate winter. On this ſide the Alps, and the Pyrenees, local circumſtances, which cannot be explained, derange often our calculation and the period. I gave that conjecture therefore only as probability, but it has been improperly conſidered as a prediction." LALANDE.

INOCU-

INOCULATION OF SHEEP.

It appears that the practice of inoculating ſheep for the ſmall-pox is now common in Germany. We are informed that a M. von Hofman cauſed this operation to be performed on his whole flock, and that not one of them died. A ſcratch was made in the ſkin of the right hind leg, three or four inches from the hoof, and a ſmall drop of matter ſqueezed from a ripe puſtule was rubbed into the wound. A plaſter an inch and a quarter long, and an inch broad, was then applied over it. Profeſſor Beckmann, to whom we are indebted for this article, ſays he does not know whether it has been proved by experience that ſheep inoculated in this manner are ſecured againſt future infection. This point indeed does not ſeem to be yet determined; otherwiſe, the Royal Society of Gottingen would not have made it the ſubject of a prize queſtion.

DEATHS.

On the 16th of February, at Munich, of a ſtroke of the apoplexy, Charles Theodore, elector Palatine, who as a friend to the arts and ſciences deſerves a conſpicuous place in the annals of literature. A chronological catalogue of his inſtitutions may be found in F. P. Wundts *Eſſay towards a general Hiſtory of the Palatinate of the Rhine.* In the year 1763 he founded the Academy of Sciences at Manheim, which ſince its eſtabliſhment has certainly been of great utility by its reſearches into ancient hiſtory and geography. At the ſame time that the Academy was founded, a Cabinet of Antiquities was begun. In 1769 the Phyſical Economical Society at Lautern was eſtabliſhed; and in 1774 the High School, which in 1784 was transferred to Heidelberg and united with the Univerſity of that place. The German Literary Society at Manheim eſtabliſhed in 1775 was founded alſo by this Prince, as well as the Cabinet of Natural Curioſities begun in 1765; the Botanical Garden; the

Military

Military Anatomical Theatre; the Chirurgical College; the School of Midwifery, and the School for attending on the Sick. He augmented the Court Library at Manheim with the scarcest and most valuable works; expended considerable sums on the Observatory of that city, and raised it to be one of the first not only in Germany but in Europe. To encourage and promote the fine arts, he established in 1775 the Academy of Drawing and Sculpture at Manheim, a Hall for copying Paintings with a valuable collection of pictures, and the German National Theatre, which, by the zeal of M. von Dalberg and the talents of excellent performers, soon became one of the most celebrated in Germany.

On the 2d of April, at Lizieux in Normandy, Charles Lemonnier, the oldest of the contemporary French astronomers. He was born on the 20th of November 1715, and had a great share in the expedition undertaken in 1735 for measuring a degree of the meridian in the north.

TO THE EDITOR OF THE PHILOSOPHICAL MAGAZINE.

SIR,

IN a collection of minerals in my possession there are several specimens which I suspect to contain Mr. Klaproth's new semi-metal uranite; but as they are handsome, and not large, am unwilling to sacrifice them to analysis to know their contents.

If any of your mineralogical readers can, through the channel of your useful Magazine, point out by what means the presence of uranite can be ascertained in such small pieces only as can be detached from cabinet specimens, I shall be much obliged to him.

By giving this a place in your next Number, you will oblige one who wishes every success to the Philosophical Magazine.

June 15, 1799. A. B.

THE

PHILOSOPHICAL MAGAZINE.

JULY 1799.

I. *On the Longitudinal Vibrations of Strings and Rods, with Obfervations on the Conveyance of Sound through folid Bodies. By Dr.* CHLADNI *of Wittemberg**.

PHILOSOPHERS formerly were acquainted only with the longitudinal vibrations of the air in a founding pipe, where, as is well known, the pipe or tube itfelf is not the fonorous body, but the column of air contained in it, which, according to the direction of its length, contracts and expands in various ways. That folid bodies alfo can vibrate in the direction of their length, according to the fame laws, as the above elaftic fluid in a pipe; and that the laws of this longitudinal vibration are totally different from thofe of tranfverfal vibration, I firft fhewed in regard to ftrings in my difcoveries refpecting the Theory of Sound †, and in regard to rods in my work on the Longitudinal Vibrations of Strings and

* Extracted from his work on that fubject, entitled, *Ueber Longitudinalfchwingungen der Saiten und Stäbe. Nebft beygefügten Bemerkungen über die Fortleitung des Schalles durch fefte Körper.*

† Entdeckungen über die Theorie des Klanges, p. 76. See alfo *Berliner Mufikalifchen Monatfchrift.* Auguft 1792.

Rods. A ſtring can extend and contract itſelf either wholly in the direction of its length, or divide itſelf into two, three, four, or more parts, each of which is ſubject to a movement of the like kind. The tones, which in compariſon of the tranſverſal tones are exceedingly high, are to each other as the numbers 1, 2, 3, 4, &c., or as the number of the vibrating parts. They ſo far correſpond with the tranſverſal tones, that in the ſame kind of vibration they are in the inverſe ratio of the length of the ſtrings; but totally differ from them in this, that the thickneſs and extenſion of the ſtring are of no account, and that, for this reaſon, more depends upon the nature of the ſubſtance. Thus the tone of a braſs ſtring is about a ſixth or a ſeventh higher than the tone of a cat-gut ſtring; and the tone of a ſteel ſtring is a fourth or nearly a fifth higher than the tone of a braſs ſtring. On the other hand, in the tranſverſal vibrations of a ſtring, the tone, as is well known, does not depend on the quality of the ſubſtance, but on the length, weight, and degree of tenſion. A ſtring, therefore, which vibrates longitudinally, is not to be conſidered ſo much as a thread-like body rendered elaſtic by tenſion, but as a piece of matter extended in length, and which vibrates exactly in the ſame manner as a rod or ſtaff faſtened at both ends. When a ſtaff is free at both ends, in its firſt manner of longitudinal vibration, there is a certain point in the middle at which the vibrations of each half ſtop; in the next there are two, each at the diſtance of a fourth part from the end; and in the following there are three, &c. The tones correſpond with the natural ſeries of the numbers 1, 2, 3, 4, &c. If a rod be faſtened at one end during the firſt kind of longitudinal vibration, the alternate expanſion and contraction of the whole rod take place in ſuch a manner that they ſtop at the fixed end; in the next tone there is a reſting point at the diſtance of one-third from the free end; and in the following there are two, &c. The tones correſpond with the numbers 1, 3, 5, 7, &c., and the firſt of theſe tones is an octave lower than

the firſt tone of the ſame rod when perfectly free. All kinds of longitudinal vibrations can be beſt produced by proper friction or rubbing in the direction of the length with the finger, or any ſoft ſubſtance rubbed over with pounded reſin, and on glaſs rods, of which thoſe uſed for thermometers and barometers are the fitteſt, with a wet rag beſtrewed with fine ſand; from which it is evident that the rubbing muſt be performed within a vibrating part, and that the rod muſt be gently held between two fingers of the other hand at any of the reſting points, but at no other place. In pipes the higher tones are produced by a ſtronger and ſomewhat different method of blowing. In a pipe open at both ends, the column of air contained in it vibrates like a rod free at both ends; and the column in a pipe cloſe at one end, like a rod which is fixed at one end. In all longitudinal vibrations, the tones, during the ſame kind of vibration, depend merely on the length of the ſonorous body, and on the quality of the ſubſtance: the thickneſs, and other circumſtances in regard to form, are of no conſideration. I have examined every ſubſtance which I could obtain in a ſufficiently long rod-like form, in regard to longitudinal vibration; for example, many kinds of wood and metal, alſo glaſs, whalebone, &c. The ſpecific gravity makes no difference; for fir-wood, glaſs, and iron, give almoſt the ſame tone, as alſo braſs, oak, and the ſhanks of tobacco-pipes made of clay.

As ſound is conducted alſo by longitudinal vibrations, ſince a portion of air, or of any other ſubſtance, is obliged by the impulſe of the ſonorous body to contract and again expand itſelf, a more accurate knowledge of longitudinal vibration may ſerve to determine with what velocity ſound is conducted through hard bodies. Count Giordano Riccati, in his excellent work on Strings or Elaſtic Fibres *, has proved that ſound paſſes through a ſpace filled with air, of a given length,

* Delle Corde ovvero Fibre Elaſtiche. Bologna, 1764. 4. Sched. v. § 5. and Sched. viii. diſt. 1.

in the ſame time that a column of air of the ſame length, contained in a pipe open at both ends, makes one vibration. Newton in his *Principia** ſays the ſame thing in another manner, for he aſſerts that each ſtroke *(pulſus)* paſſes through twice the length of an open pipe; but he calls a double vibration, that is, a contraction and expanſion, a ſtroke; whereas Riccati and others, agreeably to the common mode of expreſſion, call each contraction, as well as each expanſion, a vibration. The principles on which this propoſition depends, ſeem to be of ſuch a general nature that they may be applied to hard bodies; and thus we may at leaſt admit, with the greateſt probability, that ſound paſſes through every body in the ſame time in which that body, when it vibrates freely, makes one longitudinal vibration. We are taught by experience, that ſound moves through the air with a velocity of about 1040 Paris feet in a ſecond; we learn alſo from experiments and calculation, that in a ſhut pipe of five feet, and an open pipe of ten feet, 100 vibrations are made in a ſecond. According, then, to the above propoſition, ſound muſt paſs through ten times a hundred, that is, 1000 feet in a ſecond. That the velocity is ſomewhat greater, being about 1040 feet, does not however contradict the propoſition; for the column of air actually agitated by the ſounding of a pipe, is always a little longer than that contained in the pipe; as Count Riccati has proved in the before-mentioned work, and as people may be eaſily convinced through experience, by holding the hand cloſe to the mouth of a pipe, where the vibration of the air will be ſtrongly felt. Hard bodies, if the above propoſition be univerſally true, muſt conduct ſound with greater velocity in proportion as the tone is higher, which is emitted by the ſame length and with the ſame kind of longitudinal vibration. Now the tones of a rod of tin are about two octaves and a large ſeventh higher; one of ſilver, three octaves and a whole tone; one of copper, nearly three octaves and a

* Princ. Philoſ. Nat. lib. ii. prop. 50. in ſchol.

fifth;

fifth; and one of iron or glafs, about four octaves and a half tone higher than the column of air in an open pipe of the fame length. If one therefore had a fufficiently long feries of fuch fubftances, the velocity with which found is conveyed through tin would be found to be 7800, through filver 9300, through copper 12,500, through glafs and iron 17,500 Paris feet in a fecond. The kinds of wood I have examined would conduct found from about 11,000 to nearly 18,000, and burnt pipe clay from about 10,000 to 12,000 feet in a fecond.

Profeffor Wünfch, in fome papers which he read before the Academy of Berlin * in 1788 and 1789, made known experiments to which he was led by Hook's Micrographia, and from which he infers, that found moves with infinite velocity through hard bodies, or with the fame velocity as light. It follows, however, from the experiments which were made with a feries of wooden laths not of confiderable length, that found was conducted through thefe fooner than through the air.

Hard bodies, in regard to the ftrength with which they convey found, feem to exceed air; fo that we may confequently admit that air, though the moft common conductor of found, is however one of the worft conductors of it. If a man holds one end of a ftick in his teeth, and applies the other to a founding body, he will clearly hear the found of it though his ears be ftopped; and in this manner two perfons, almoft deaf, could hear all the notes of my euphon †, even in pianiffimo ‡. If one holds between the teeth a thread, to the end

* Berlin 1793-4.

† For an account of the Euphon fee Phil. Magazine, Vol. II. p. 391.

‡ About fifty years ago a merchant at Cleves named Joriffen, who had become almoft totally deaf, fitting one day near a harpfichord while fome one was playing, and having a tobacco-pipe in his mouth, the bowl of which refted accidentally againft the body of the inftrument, he was agreeably and unexpectedly furprifed to hear all the tones in the moft diftinct manner. By a little reflection and practice he again obtained the ufe of this

end of which is ſuſpended a large ſilver ſpoon, and beats it againſt any thing, he will hear a noiſe, even if his ears are ſhut, equal to that of a large bell. Perolle has given excellent obſervations on the capability of hard bodies to conduct ſound, in the Memoirs of the Academy of Turin for 1790 and 1791. Articulated tones alſo are conducted exceedingly well through hard bodies, as I found by experiments which I made with ſome of my friends. Two perſons who had ſtopped their ears could converſe with each other when they held a long ſtick, or a ſeries of ſticks, between their teeth, or reſted their teeth againſt them. It is all the ſame whether the perſon who ſpeaks reſts the ſtick againſt his throat or his breaſt, or when one reſts the ſtick which he holds in his teeth againſt ſome veſſel into which the other ſpeaks. The effect will be greater the more the veſſel is capable of a tremulous movement. It appeared to be ſtrongeſt with glaſs and porcelain veſſels; with copper kettles, wooden boxes, and earthen pots, it was weaker. Sticks of glaſs and next fir-wood conducted the ſound beſt. The ſound could alſo be heard when a thread was held between the teeth by both,

this valuable ſenſe, which, as Bonnet ſays, connects us with the moral world; for he ſoon learned, by means of a piece of hard wood, one end of which he placed againſt his teeth, while another perſon placed the other end in the like manner, to keep up a converſation, and to be able to underſtand the leaſt whiſper. His ſon made this beneficial diſcovery the ſubject of an inaugural diſſertation under the following title: "*Diſſertatio medica ſiſtens novi methodi ſurdos reddendi audientes phyſicas et medicas rationes.* Præſ. ANDR. EL. BUCHNERO; auct. JO. JORISSEN. Halæ, 1757. 4. One hears moſt diſtinctly when the end of the ſtick reſts againſt the upper fore-teeth, or rather when it is held between the teeth: if placed only againſt the lower teeth, it will be of no avail. The natural cauſes of this and many other variations which the author and his father tried, are explained in the above uſeful Tract, which was afterwards publiſhed in German, by the preſident, with the title of, *Büchners Abhandlung von einer beſondern und leichten art Taube hörend Zu Machen: Nebſt andern Anmerkungen. 1te Samml.* Halle 1759. 8.—[This note is by Profeſſor Blumenbach. EDIT.]

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ſo as to be ſomewhat ſtretched. Through each ſubſtance the ſound was modified in a manner a little different. By reſting a ſtick or other body againſt the temples, the forehead, and the external cartilaginous part of the ear, ſound is conveyed to the interior organs of hearing, as will readily appear if you hold your watch to theſe parts of another perſon who has ſtopped up his ears. From this it appears, as well as from many known experiments made in regard to hearing under water, that in moſt of our books on the elements of phyſics, in which in general accouſtics have had the undeſerved fate of being treated in a much more imperfect manner than other parts of philoſophy, ſound is very improperly conſidered only as a vibration of the air, and the theory of it referred to the head of Air. Hearing is nothing elſe than, by means of the organs of hearing, to be ſenſible of the tremulous movement of an elaſtic body, whether this tremulous movement be conveyed through the air, or any other fluid or hard body, to the auricular nerves. It is alſo eſſentially the ſame whether, as is uſually the caſe, the ſound be conveyed through the internal part of the ear, or whether it be communicated through any other part of the body. It certainly would be worth the trouble to make experiments to try whether it might not be poſſible that deaf and dumb people, when the deficiency lies only in the external organs of the ear, the auricular nerve being perfect, could not, by the above method of conducting ſound, be made to hear diſtinctly words articulated as well as other ſounds.

II. *Obſervations on the true Origin of the Goſſamer.* *By* J. M. Bechstein*.

To explain the origin of the goſſamer is an old problem, which, after a number of experiments, no one, as far as I know, has yet fully ſolved. Some naturaliſts have conſidered

* From *Magazin für das Neueſte aus d. Phyſik.* Vol. VI. Part I. p. 53.

this phenomenon as the evaporation of plants condenſed during the cool days of harveſt by the air, and converted into threads like thoſe which can be drawn from reſinous juices; others, as the production of a kind of ſpider, on account of its ſimilarity to the threads of common ſpiders*: and M. D. C. Tereboom has lately diſcovered a kind of beetle furniſhed with a veſicle on its back, from the hinder part of which, on both ſides, proceed two threads that extend over the extremity of the body, and end in a double thread, ſometimes ten or more ells in length; and this thread is ſuppoſed to be what is commonly called the Goſſamer.

After many years experience and obſervations made almoſt daily when this phenomenon appeared, I flatter myſelf that

* In the country, during autumn, certain threads are ſeen hanging from the trees, or extended on the buſhes, and even the graſs, which, when agitated by the wind, detach themſelves from the branches, are tranſported to others, and are joined or ſeparated at the pleaſure of the breeze. People in walking often find their faces, hair, and clothes, covered with them. They are generally called the threads of St. Martin *(filets de St. Martin)*, becauſe it is about St. Martin's day that they appear in the greateſt abundance. When the moiſture of the atmoſphere and the dew attach themſelves to theſe threads and become congealed, ſo that the threads appear thicker and whiter, the peaſants call them the hair of the Virgin Mary *(cheveux de la Vierge Marie)*. Having one day aſked them the cauſe of this production, they unanimouſly replied, and without variation, that it was the vapours of the earth, which at that ſeaſon are thicker and denſer. I had no great confidence in this opinion: but I ſoon learned the real truth; for, being in a field overſpread with heath in the time of autumn, I obſerved that almoſt all the heath-buſhes were covered with ſpiders webs, and when theſe were opened I found incloſed in each a ſpider. Theſe ſpiders were ſmall, of a red colour, and marked with ſpots; their feet were ſhort, and the head was large in proportion to the belly. Such ſpiders webs are found among the low ſhrubs that grow near the earth, at the bottom of ſtalks of corn which have been left ſtanding by the reapers, and in the buſhes. When the wind is ſtrong it breaks theſe webs, carries away a part of them, which are ſcattered over the ground and the trees, and hence come the threads of St. Martin. *Huetiana*, Amſterdam 1723, p. 369. EDIT.

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I am able to reſolve the problem reſpecting its origin. In my opinion the goſſamer ariſes from nothing elſe than a certain kind of field-ſpiders, which are, however, ſo ſmall and active, that they almoſt always eſcape notice, unleſs the obſerver is endowed with great acuteneſs of ſight. I would call this ſpider, if it has already no name, the goſſamer ſpider *(aranea obtextrix)* : I ſhall here give a ſhort deſcription and hiſtory of it, as far as my knowledge extends.

The goſſamer ſpider *(aranea obtextrix)* is as large as the head of a ſmall pin. On the fore-part of its longiſh head it has eight grey eyes placed in a circular form ; the extremity of the body is ſhaped like an egg; the body itſelf is of a ſhining dark-brown colour; the feet are of a moderate length, and yellowiſh ; and the whole animal is covered with inſulated hairs.

Theſe inſects firſt appear in the beginning of October, in woods, gardens, and meadows, where their eggs may be hatched unhurt and unmoleſted, and thence ſpread themſelves over whole diſtricts, ſo that during all the month of October and till the middle of November they may be found on the dry fields throughout all Europe; and as they produce a numerous progeny, extenſive tracts may ſometimes be ſeen ſwarming with them. The young, which have not attained to their full growth, are not larger than the point of a pin ; they are black, with grey feet, and almoſt imperceptible to the naked eye. In the beginning of October, when very few of them have been hatched, one obſerves only in the ſunſhine a few ſingle threads of their webs, which they extend from twig to twig, or from ſtraw to ſtraw ; but about the middle of the month their threads become more perceptible; and towards the end, if people ſtand or place themſelves in ſuch a poſition that they can ſee the ſun-beams playing on the tender threads, they perceive hedges, meadows, corn-fields, ſtubble land, and even whole diſtricts, covered with a fine white thick ſort of gauze. This ſpider belongs to that kind which do not weave webs, but only extend ſingle

threads

threads from one place to another, and which Linnæus, on that account, includes in a particular diviſion. The threads, owing to the ſmallneſs of the animal, are ſo delicate that a ſingle one cannot be diſtinguiſhed by the naked eye unleſs when the ſun ſhines upon it. A thread, to be viſible at other times, muſt be compoſed of at leaſt ſix threads twiſted together; and ſuch a thread, as the ſingle ones are exceedingly brittle and do not readily unite, may be again eaſily divided into its component threads. During the ſerene calm days of the above months theſe animals carry on their occupation with great diligence, eſpecially after the morning fogs have diſappeared. Between the hours of twelve and two, however, is the period when their great induſtry excites moſt admiration. If people are poſſeſſed of good eye-ſight, or are furniſhed with a magnifying glaſs, they may find among the barley ſtubble ſuch a multitude of theſe ſpiders employed in extending their threads, that the fields appear as if covered with ſwarms of gnats, and they perform their labour ſo ſpeedily that they ſeem to fly from one ſtubble to another.

Theſe tender threads, which are extended over whole fields, particularly in the laſt half of October, become twiſted together by the gentleſt breath of wind, and form perceptible threads, that, being broken looſe by a ſtronger wind, are united into thick threads, and even balls, that float through the atmoſphere. They are known then in Germany by the name of the *flying ſummer* *, becauſe the ſummer ſeems as it were to fly away at the ſame time. The ſpiders alſo are then conveyed along in them; and it is not uncommon to find theſe animals entwiſted in ſuch threads which have been caught †.

All

* In German *fliegende ſommer.*

† A ſingular uſe which ſome kinds of ſpiders make of their webs is, that they ſerve them inſtead of carriages to perform long journies, and to tranſport themſelves from one country to another. At certain times of the year we may generally ſee, when the ſky is ſerene, a multitude of ſtrong threads and balls formed of the threads of theſe inſects, floating about in the atmoſphere;

All the ſpiders, however, found in theſe threads or balls, muſt not be conſidered as the animals by which they were prepared; for other kinds of ſpiders, common in harveſt, are ſometimes entangled in theſe threads and carried along with them. Thus, for example, the black and white ſpotted tree-ſpider, and the ſo called cheſtnut-ſpider, are often found incloſed in the goſſamer together with their habitations, and muſt obey the impulſe of the winds.

Theſe webs, which conſiſt of threads cloſely joined together, ſerve the inſects as nets, in which they catch very ſmall black flies, gnats, and winged tree-lice, the juices of which they ſuck for their nouriſhment. The goſſamer, therefore, is often found filled with the dried huſks of ſuch inſects.

The above, in my opinion, is the real origin of the goſſamer. But why do theſe ſpiders appear only in the time of harveſt? why not earlier? and why are they not found like the houſe and field-ſpiders throughout the whole ſummer? —Theſe objections obviate themſelves. They appear at that period for the ſame reaſon that may-bugs *(maykaffer)* appear in the month of May. They are as neceſſary in their order to preſerve the equilibrium of the balance of Nature as the may-bugs are in May. Single ſpiders of this kind, however, may be found the whole ſummer through, as ſingle may-bugs are found in harveſt. To thoſe who know that exactly about this time thoſe birds, for whoſe nouriſhment inſects have been aſſigned, undertake their emigrations, and that the larks in particular, which are ſo fond of ſpiders, then leave us, the above phenomenon will not appear wonderful, but will rather be conſidered as a wiſe regulation of Nature. Thoſe who wiſh to be convinced of the truth of this obſervation need only to ſhoot a lark at that period and to open it imme-

ſphere; and when theſe threads and balls are examined, they will always be found to contain ſpiders, which have prepared theſe ſubſtances to enable them to fly without wings, and to procure themſelves an eaſy paſſage to other countries. *Théologie des Inſectes par Leſſer, avec des Remarques de P. Lyonnet.* A la Haye, 1742. Vol. I. p. 346. EDIT.

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diately. These insects, together with the grains of barley which drop from the ears, must indemnify these birds, which stop in many places on their passage in great numbers, for the loss of the summer insects.

After what has been said, I do not think that the whiteness of the threads, which arises from nothing else than the dews that fall at that period, or their clamminess when rubbed between the fingers, not observed in the threads of other spiders, and which is occasioned by the fineness of the threads, that so easily insinuate themselves into the cavites of the skin, can be brought as any objection against this mode of explanation. These phenomena can have no weight unless we ascribe these threads to the common spider. It is likewise very improbable that the gossamer is produced, as M. Pereboom asserts, by his beetle; which however must excite our admiration, because, like the spider, it weaves for itself a net, either to serve it as a habitation, or as the means of catching its prey.

III. *Remarks on Mr.* SHELDRAKE's *Dissertation on Painting in Oil in the Manner of the Venetians. By Mr.* EDWARD DAYES. *Communicated by the Author.*

PERSUADED that Mr. Sheldrake labours under a mistake, which may lead others into a practice difficult in itself and dangerous to the durability of their works, I shall offer no apology for the following remarks on his Dissertation *.

That the Venetians primed with distemper, is true; but the colour used was not a *brown*, as stated by Mr. Sheldrake, but a *red*, known at present by the name of *Venetian red*. Some artists at this time employ the same colour, previously calcined, in a new Venetian method: I say a new one, for there are two or three. One of the secrets consists in prim-

* See Phil. Mag. Vol. II. p. 302.

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ing the cloth with bone-afhes, mixed with a fmall quantity of fize or pafte, and afterwards brufhing it over with the above calcined-red.

The method of working up the picture in a ftate of black and white was certainly practifed at times by fome of the Venetians; but in that cafe the ground was no object, as the whole effect of colour was afterwards acquired by glazing: this is obfervable in the pictures of Tintoret, and fufficiently accounts for the perifhed ftate they appear under. On the contrary, where the red ground was ufed, the light and extreme dark are the only part where the colour lays in a body. Mr. Sheldrake obferves, he does "not pretend to degrade painting to the rank of a mechanical art, that may be infallibly practifed by a receipt." If the Venetians had poffeffed no higher recommendation to notice than mere colouring, they would not have fo ftrongly arrefted our attention; on the contrary, the compofitions of Titian, Paul Veronefe, &c. will ever rank among the firft. The prefent rage for colour is like preferring perfon to mind, and had it prevailed in the time of Swift, would certainly have procured fome of our profeffors a fituation at Lagoda.

The author of the Differtation muft certainly have miftaken the words of Sir Jofhua, or not underftood them. Sir Jofhua could never have faid that harmony was to be produced by "an unity of light and an unity of fhadow pervading the whole;" or, in other words, (as I underftand it,) by reducing the whole of the lights to one colour, as is implied by the word *unity*. Such a practice would deftroy the brilliancy which the author wifhes to obtain from glazing. The fimile afterwards introduced, contradicts entirely fuch an inference. "A picture, to poffefs harmony of colouring, fhould look as if it was painted with one colour; and, when the *chiaro-ofcuro* was complete, the colour of each object fhould be glazed over it." Sir Jofhua was in the fimile defcribing his own practice, and which will, for a fhort time, produce a greater brilliancy in the light. Inftead of an

"*unity*

"*unity* of *light*," the word *harmony* muſt have been uſed, as harmony of light and unity of ſhade are common terms. In note 43, on Du Freſnoy's Art of Painting, he (Sir Joſhua) expreſsly ſays: "And for the ſake of harmony, the colours, however diſtinguiſhed in their light, ſhould be nearly of the ſame colour in their ſhadows, of a

——— "ſimple unity of ſhade,
"As all were from one ſingle palette ſpread."

Every one knows that the harmony of the picture depends greatly on the ſhadows not being diſturbed with colour. That Sir Joſhua was acquainted with the method of bringing forward his pictures in a ſtate of black and white, and glazing for the colours even in his draperies, is too true, as is known to all acquainted with his practice, and was, I believe, the reaſon of their not ſtanding. His method was, with ivory black, vermilion (uſed in the carnations), and white, to bring forward his pictures to their full effect, and then to glaze for all the colours. It ſhould be obſerved, that this method might only be practiſed at times, but I had myſelf ſeveral opportunities of ſeeing it.

All the advantages obtained by the practice of glazing, as it is called, are ſo tranſitory, that they may be literally ſaid to be but the viſion of a day. Whether this ariſes from the gum in what is termed maguilp *, (a compoſition of two parts maſtic varniſh and one of drying oil,) moſtly employed for the purpoſe, or want of body of colour, I do not pretend to determine, though I think both may contribute to effect their deſtruction; the colour by flying off, and the gum by

* The above compoſition, when mixed on the palette, forms a conſiſtence like honey, with which the colours work exceedingly free. There are various compoſitions for maguilps; ſome uſing wax diſſolved in nut oil, others roſin and ſugar of lead in the ſame ſolvent, wax in ſpirits of turpentine, &c.: though I muſt own a preference for the drying oil and varniſh for diluting the colours for the touches or pluming on a part, but for the mere act of glazing I prefer good clear oil.

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losing its transparency. One thing I have frequently had occasion to remark in the use of water colours (in a transparent state), that the more gum is mixed with them, the sooner they fly. As far as glazing goes to enrich a colour it is necessary; but that is a very different practice from the one I now speak of.

Many substances employed as pigments give black, or dead, heavy colours; as Prussian blue, indigo, dark lake, and indeed all colours that are transparent when viewed in a lump; but, spread on a white ground, or mixed with any colourless matter, they appear in all their vigour. If, instead of a white ground, a grey or brown is used, the vivacity will be more or less in proportion to its darkness. These facts furnish strong reasons for preferring a white ground, and may account for the darkness in many of the Venetian pictures, from their glazing with transparent colours on a dark surface, and, as before stated, the loss of clearness in the vehicle used (no doubt a gum); but this appears to have been only an occasional practice.

The Dutch painters, whose mechanical excellence was inferior to none, always used white grounds prepared with the greatest care. They spread well-washed chalk mixed with size over the surface to be painted on, which if nicety was required they pumiced, and repeated the operation till the surface was even; after which they laid over it a coat of the finest flake white. The whole picture was then painted fair, (that is, with a body of colour,) except the shades, which were kept clear and transparent, and received an additional lustre from the ground. That this was their practice may be easily seen in all their interior scenes and the close parts of their pictures.

It is much to be wished that, instead of brilliancy, *permanency were sought after*; while the Venetian pictures are going fast to decay, the works of Van Eyck, Quintin Matsys, and John de Mabuse, remain fresh and vigorous.

With respect to shadow being a privation of light, it is

readily admitted, and it equally follows, that it is a privation of colour; but this circumſtance ſhews, as before ſtated, that much of the harmony of the picture muſt depend on its not being diſturbed with colour. Where Mr. Sheldrake attempts to illuſtrate this doctrine, by ſuppoſing a globe expoſed in a painter's room, he ſeems rather to have confuſed the matter by too many diviſions. Artiſts divide the ſurface of all bodies into light, middle tint, ſhadow, and (which Mr. Sheldrake has forgot to add to his globe, to round it) reflection. There are two things the author of the diſſertation appears to have overlooked, and which eaſes the difficulty of producing the harmony neceſſary to conſtitute a whole: firſt, the method (ſaid to have been at firſt practiſed by the Venetians) of breaking the colours, ſo as to make them all partake in ſome meaſure of each other, and which was at times carried to a degree of inſipidity even by Titian; and ſecondly, (and which I think the moſt eſſential,) the grouping the warm colours together ſo as to form a maſs, and letting them occupy the greateſt portion of the picture. The latter appears to have been the practice of Rubens and others of his ſchool, and which enabled him to introduce the whole ſcale of colours in the ſame picture, from the hotteſt to the oppoſite extreme of cold; this gives a vigour to his colouring beyond all other maſters.

The method of working up the picture in a ſtate of black and white, was certainly never practiſed by the Flemiſh maſters. The beauty obſervable in the colouring of Rubens (whoſe demi-tints are wonderfully clear) reſulted from a firmneſs in the handling, a ſimplicity and diſtinctneſs in the tints, and a particular care to avoid muddling them in uſing: I do not mean to ſay they never glazed, or ſcumbled to give richneſs; but that was done in a different manner to the one deſcribed in the Diſſertation. In ſome of his ſlight pictures the tones in the fleſh may be traced as follows: the light yellow, next the carnations, then the grey, next the ſhadow, glazed to give it clearneſs, and his reflections generally very bright;

bright; but in his finifhed works they are of courfe more blended. Every artift knows, or ought to know, that there are but three primary colours, red, blue, and yellow; the compound colours, which refult from combining thefe, amount to four, making in all feven. Red and blue, when mixed, produce purple; red with yellow, orange; blue and yellow, green; the three united, a brown, black, or grey, as the warm or cold colours prevail. Thofe conftitute all the colours and tints in nature, mixed with more or lefs white. The fewer colours ufed by the artift the better he will colour, from the practice being rendered fimple, and the poffibility of muddling in fome meafure deftroyed: for, *it is not the mixing colours that hurts, but the mixing many*; two colours will always be clearer than three, and fo on. Though the above confiderations offer a fimple theory of colouring, yet in practice the artift muft have judgment enough to acquire at once the precife tint he wants, to infure clearnefs and brilliancy. The fingular fact of white appearing grey on a brown ground, I fhould fuppofe to arife from white being cold, and from its contraft with the brown. That a picture painted in brown and white fhould be in perfect harmony is not to be wondered at, as it can only be termed an effect of light and fhade. The brown ufed by the Venetians has, with great probability, been fuppofed a preparation of afphaltum.

As the practice of glazing is the laft operation in painting, and as in the doing it the artift ufes in the fhadows fome tranfparent dark colours, it of courfe follows, thofe fhadows muft be kept tenderer to receive the glaze, which may be extended to the demi-tints if kept tender in proportion alfo: this will produce the deceptive appearance Mr. Sheldrake fpeaks of in the Venetian pictures, and do away the weight refulting from mixing, as he fays, "fome dufky colour with the local colours and the light." The above method, with the practice of fcumbling on the lights, or

merely enriching a colour by glazing, in my opinion sufficiently accounts for Venetian brilliancy.

What is meant by black and white not being the painter's extreme of light and dark, I profess not to underſtand: all that I know is, that the artiſts have to lament, as well as Mr. Sheldrake, the being obliged to repreſent ſhadow with a ſubſtance, and that even glazing them thin is but a poor imitation of the real appearance. With reſpect to "the painter's art being to repreſent objects as they appear, in point of colour, to be not as they really are," I am equally at a loſs to underſtand the author, having ever been taught to conſider all colour as comparative; and therefore, that black at 50 feet diſtance was no longer ſo, and to call it black would be as abſurd as to call twilight night.

If I judge right, (from the author's recapitulation,) there are three ſtages in his proceſs; firſt, the darkeſt tints, then the lights, and laſtly the colouring. Now I think it is evident, from the oil being inſtantly abſorbed by the ground, that it would be utterly impoſſible to blend the lights and darks together ſo as to make the picture mellow. Then comes the glazing for the colours, which is bad, as experience has ſufficiently ſhewn the want of durability: beſides, for ſuch a proceſs, oil makes the colours too thin to work: this made the artiſts reſort to the expedient of uſing maguilp, which has the injurious tendency before ſtated. What made theſe artiſts ſo deſirous of a clearneſs in the ſhades, was to give them that non-ſubſtantial appearance Nature puts on: in his lights, it is true, the artiſt wants brilliancy, to acquire which he occaſionally glazes or ſcumbles; but every good artiſt knows, that the leſs recourſe he has to the former practice, the more permanent his picture will be.

After all the conſideration I have been able to give this ſubject, I am inclined to think that the Venetian method, judging from a picture by Tintoret now before me, was more like that followed by Sir Joſhua Reynolds, as above de-

ſcribed;

scribed, than the one recommended by Mr. Sheldrake. *Titian glazed on colour, Tintoret often on white*; and I think it will invariably be found, that the works of the latter are more perished than the former. That exquisite lightness attendant on a dead colouring, may, in a great measure, be restored by scumbling.

The plan he has proposed, and which seems to have been resorted to, to remove the practical difficulties he met with, is merely to paint in varnish; a method which always gives brightness for a short time. The objections to its adoption may be summed up in a few words: first, the difficulty of blending the colours used to produce the effect of light and shade; and secondly, (which is by far the most material,) the want of durability in the colours, as they must all be acquired by glazing; not to mention the strong similitude between it and Sir Joshua's method, as above described.

As I never bought Miss Provis's secret, I cannot tell how close the approximation may be between her method and the one proposed by Mr. Sheldrake; but if I may judge from practical experience, they would both be productive of hardness; and as some of the colours in the pictures painted after her method carried evident marks of destruction on them, I was immediately induced to suppose that some calcareous earth was used in the ground *. Though I much question the utility of Mr. Sheldrake's plan, I think he unquestionably deserves the thanks of the public, and of artists in particular, for the time and trouble he has bestowed on it.

* Lime and terra ponderosa destroy the colouring matter of Prussian blue; some drawings, hung up in a house that had undergone a considerable repair, lost all their blue colour, which had become a dirty iron grey.

IV. *Progreſs of Dr.* MITCHILL'S *Mind in inveſtigating the Cauſe of the Peſtilential Diſtempers which viſit the Cities of America in Summer and Autumn. Being a Developement of his Theory of Peſtilential Fluids, as publiſhed to the World in* 1795 *and the ſucceeding Years.*

[Concluded from Page 43.]

WHILE theſe inquiries were making, a memorable diſpute was carried on in ſome of the Atlantic cities, Whether the exciting cauſe of yellow fever was of domeſtic origin, or imported from foreign places in ſhips and merchandize? The prevailing opinion at New-York was, that there were local cauſes enough for the production of that diſtemper in the city itſelf. With the intention of removing the cauſes of this plague from the town, the Legiſlature, then ſitting at Albany, 160 miles diſtant, rapidly paſſed a bill prohibitory of certain trades and manufactures within the compact part of the city. The act forbade, among other things, the *manufacture of ſoap and candles* under a heavy penalty, except at definite diſtances from the houſes and ſettlements. The deſcription of citizens engaged in theſe branches of buſineſs preſented immediately a memorial to the Legiſlature for relief on this occaſion, and retained Dr. Mitchill as their counſel to manage the buſineſs of procuring ſome terms of mitigation at the ſeat of Government. In drawing up the argument in favour of his clients, he became more firmly convinced than before, that ſubſtances compoſed of carbone and hydrogene, ſuch as *fat*, *greaſe*, and *oil*, were incapable of yielding peſtilential air; and that the ſubſtances containing *ſepton*, to wit, the *ſkinny*, *lean*, *muſcular*, and *membranous* parts of animals, together with the *blood* and *alimentary fæces*, were the ſubſtances whence unhealthy and noxious exhalations proceeded. From a general and broad induction of facts arranged in the argument employed on that occaſion, it was rendered clear, that the ſubſtances containing

ſepton,

fepton, and none others, were known to afford peftilential air. The fame rule applied to *vegetable productions*, of whatever kind they might be. On this occafion it was exhibited in evidence, that the perfons who were engaged fteadily among the *afhes*, *foap*, and *fat* of thofe manufactories were protected as it were from peftilential difeafes, and fared mightily better than their neighbours.

A part of this doctrine foon after received confirmation from Count Berchtold's and Conful Baldwin's account of the beneficial effects of *oil* in keeping off and relieving the *fymptoms of the plague* in Afia, and from the remarkable exemption of the Nantucket whalemen from malignant fevers on their long voyages over every part of the ocean.

From the furvey of the facts relative to *alkalis* and *oils*, there could hardly remain a doubt that they acted upon the *acid of peftilence*, by neutralizing or decompounding it: ftill, if this acid confifted of fepton and oxygene chemically united during the putrefaction of organized bodies, why did not thofe elementary fubftances, it was afked, which conftitute the bafes of azotic and vital airs refpectively, incorporate in the atmofphere, where they exift in ftates apparently very favourable to combination? The reafon appears to be, that after fepton and oxygene, in their feparate forms, have connected themfelves with caloric enough to form diftinct gafes, they are repelled thereby to diftances greater than chemical attraction can reach, and therefore remain feparate. This idea, which Dr. Mitchill originally ftarted, has fince been confirmed by Citizen Guyton's account of the poffibility of bringing the bafes of the two airs into chemical union, by compreffing them with a force equal to feveral atmofpheres; a part of the caloric in fuch cafes, according to Dr. Darwin's idea, being crowded out after being compelled to quit its hold. Indeed it feemed evident that the chief difference between common air and peftilential air confifted merely in this; that in the former, the fepton with caloric formed azotic air, and the oxygene conftituted vital air, each diftinct

diſtinct from the other; whereas in the latter caſe the ſepton and oxygene are chemically blended with each other, baſe with baſe. The reaſon of their readineſs to unite during the putrefactive proceſs now became evident. The baſes of the two airs ruſhed into union *before* they had attracted caloric enough to turn them to ſimple gaſes, and give them the repellency incidental to that condition.

The venomous and deadly qualities of nitrous acid had been aſcertained by Eaglefield Smith in his experiments upon ſmall animals inoculated with it.

A caſe occurred during Dr. Mitchill's attendance as one of the phyſicians of the New-York Hoſpital, where *fever* appeared to have been brought upon a patient by the nitric acid abſorbed from the decompoſition of a large quantity of red precipitate with which an ulcerated leg had long been dreſſed.

Several inſtances had come to his knowledge, of ſevere diſorder in the alimentary canal, terminating in *dyſentery*, from an accidental drinking of diluted aquafortis.

It immediately ſtruck him, that privies and collections of human ordure had been long noted for containing ſeptic (nitric) acid. The effluvia of privies had in ſeveral inſtances been known to excite dangerous ſickneſs. Many of the articles of diet contained ſepton; and oxygene, in ſome form, always exiſted in the alimentary canal. As the contents of the ſtomach and inteſtines were inanimate, it was exceedingly probable that, in certain caſes of indigeſtion and coſtiveneſs, ſeptic acid might be formed in the cavities of theſe abdominal viſcera; and that irritation and inverſion of the motions of the ſtomach, in ſome forms of *yellow fever*, as well as ſpaſms of the colon, griping pains and teneſmus in ſome of the caſes of *dyſentery*, PROCEEDED FROM THE SAME EXCITING CAUSE.

By an induction of facts from the operation of *neutral ſalts* in theſe kinds of diſtempers, it appeared, that the moſt efficacious and ſalutary were thoſe which are capable of de-

compoſition

composition by *septic acid*, if it existed in the intestines; and that really, besides their cathartic effect, they possessed a power, derived from their *alkaline bases*, to neutralize that mischievous and tormenting liquid. From this principle Dr. Mitchill investigated a theory of the *modus operandi* of these numerous and important articles of the MATERIA MEDICA.

Frequent instances afterwards evinced the justness of this interpretation; for in the New-York Hospital, as well as in private practice, he found watery solutions of the carbonates of pot-ash and soda to be most excellent anti-dysenteric remedies, and valuable prescriptions in the cholera infantum. The administration of the carbonate of soda *in clysters*, to allay tenesmus, was suggested to Dr. Mitchill by Dr. Lent, then apothecary of the house, and found, on repeated trials, to be a valuable remedy. Dr. Saltonstall has treated of the application of this principle to explain yellow fever, and Dr. Bay to elucidate dysentery, in their several inaugural dissertations published in COLUMBIA COLLEGE.

After being called to the Professorship of Chemistry, Natural History, and Agriculture, in that seminary, Dr. Mitchill delivered these doctrines publicly in his annual course of lectures. The dissertations just mentioned shew with what zeal and success they were discussed and applied by his hearers. And a circumstance worthy of notice respecting *both* the gentlemen last named, is, that they witnessed and lived through the plagues they have described.

A general inference from all the phenomena was, that these miasmata or contagions, in all their forms herein contemplated, were violent STIMULANTS, as Brown had originally conjectured.

But the application of this doctrine to AGRICULTURE was not much less interesting than its relation to Medicine. Dr. Mitchill was born in the parish of Hempstead, in Queen's County. His father was a landholder, and cultivated

vated his own eſtate, as is common in America. The early part of his life, to the age of ſeventeen years, was paſſed in the country. In the way he was educated, the implements of huſbandry, and the method of uſing them, were familiar to him: he knew the management of the plough and of the ſpade. After the death of his father in 1789, he took poſſeſſion of the family-patrimony, and lived on it as a practical farmer for ſeveral years. His experience and opportunities during this ſeries of agricultural employment, had produced, among other things, a more curious and particular attention to MANURES.

On reviewing his former obſervations, the ſubject preſented itſelf to him under ſeveral new aſpects. The production of *ſeptic acid* among the excrements of animals had been long known: the neutralization and fixation of this was, he thought, one of the principal effects wrought by *alkalies* and *lime*. Inſtead of ſaying, with the generality of modern obſervers, that lime was ſerviceable by its ſeptic or putrefying quality, (an opinion for which there is no plauſible foundation,) Dr. Mitchill became convinced, its principal effect was, to combine with ſeptic acid into calcareous nitre, one of the richeſt of manures; and reſerve this, without volatilization or evaporation, fixed upon the ſoil, to ſtimulate and feed the plants which grow there. Thus wholeſomeneſs and fertility were provided for in the ſame operation. It ſeemed to him alſo, that the deliqueſcent property of the ſeptite of lime enabled it to retain moiſture a long time upon the land, and thereby moſt agreeably ſecured the crop from the pinching of drought.

It was obvious, that if there was much ſeptic venom (oxygenated ſepton) in any field, yard, or region, and no lime or alkali to neutralize it, epizootic diſeaſes among cattle might proceed from it, after the manner of epidemic diſtempers among the human ſpecies. Dews and fogs impregnated with ſeptic acid, appeared the probable exciting cauſes of ſeveral mortal diſorders in neat-cattle, ſheep, and horſes; a conſiderable

confiderable quantity of fuch dilute aquafortis being taken into their bodies as they grazed during the night. He thought this was corroborated by the fymptoms related by Lancifi to have been obferved in the cattle fick of fuch difeafes in Italy.

And it was no lefs plain that *ruft* and *mildew* in wheat were owing to the fame caufe.

The unwholefomenefs of certain dews, in certain places and times, was evidently, he believed, to be afcribed to a portion of feptic acid gas, volatilized during the heat of the day, and precipitated with a portion of atmofpheric water in the cool of the night.

With this branch of the enquiry was connected the whole hiftory of nitre, and the pits, beds, and caverns wherein it was produced, whether fpontaneoufly, or by the hand of man. The interpretation of all the facts relative to which amounted to this; that the alkali neutralized the *acid poifon of putrefaction*.

On looking around, it could not efcape Dr. Mitchill, that the fweetening and cleanfing effects of *lime*, *alkaline ley*, and *foap*, in DOMESTIC ECONOMY, were now capable of an eafy and complete explanation. The fweat, perfpiration, and excreted matter of almoft every fort, which rendered clothing, bedding, furniture, and houfes foul, contained fepton; and confequently, in the heat of the human body, *feptic acid* might be produced in quantity and ftrength fufficient to excite many morbid *affections of the fkin*, and, if abforbed, engender the *worft forms of fever*. Lime, ley, and foap rendered the human body, its clothes, bedding, &c. pure and wholefome, by their power of attracting all kind of peftilential matter, and carrying it clean off. He therefore became fatisfied that the old maxims of female management were beft; for he never knew infection break out where there was a SMART WOMAN for a houfekeeper: the reafon was, fhe *kept the mifchief down by alkalies*. On the other hand,

hand, wherever MEN, especially those who set up for PHILOSOPHERS, took the lead; as in prisons, workhouses, hospitals, and ships; there were for ever complaints made of the rise and progress of malignant distempers: the reason was, they increased the evil by acid fumigations *.

Numberless instances had happened in New-York, of persons being *poisoned*, and many of them to death, or, in other words, catching the yellow fever, from the septic vapour of corrupting *beef* and *fish* cured with too small a quantity of salt. These are mostly *lean* animal substances. On their corruption they afford the most deadly effluvia. The frequency of stinking provisions of these kinds, and of the poisonous vapours they emitted, led Dr. Mitchill to investigate a theory of the muriate of soda in preserving animal flesh from putrefaction. The result was this: when septic acid is formed in a barrel of beef, the common salt is decomposed; and while the septic acid combines with the soda, the muriatic acid is set loose to impregnate and preserve the meat. When there is too little muriate of soda, the septic acid, becoming volatile, often sickens, and even kills the persons who are exposed to it.

This interpretation led naturally to an inquiry into the use of the *bile of animals*; which, instead of being a *vile, troublesome, excrementitious*, and *corruptible* liquor, as it has been fashionable to term it, turns out to be a grand preserver of health, by virtue of the *soda which it contains*; being always ready to pour itself into the duodenum, and even regurgitate into the stomach, to neutralize any portion of septic venom which may have been swallowed or engendered there. Of all the fluids the animal body contains, the gall is the least liable to corruption, or alteration unfriendly to health.

* The author of the present paper was not perhaps aware of the strong evidence in favour of the utility of acid fumigations that has been brought forward by Dr. Smyth, Mr. Cruickshank, and others. EDIT.

There

There are many more inductions of facts which unite in the establishment of the general principle Dr. Mitchill has investigated. Some of these have been published in America, and some exist still in manuscript. The desire of writing a book seems never to have influenced him. Accordingly he has generally conducted his discussions in the form of letters to his friends and correspondents: and even these he has never collected into a volume; they lie scattered about in magazines and dissertations where they were first inserted. There is a promise, however, of printing the whole in the Medical Repository, where they may in succession be laid before the learned world. In this immense inquiry, it is hoped, he will be assisted by the candour and talents of those scientific inquirers who are now-a-days making such vast discoveries in Europe.

V. *Account of a Voyage to Spitsbergen in the Year* 1780. *By* S. Bacstrom, M.D. *Communicated by the Author.*

SIR,

HAVING received much gratification from a perusal of your Magazine, I send you a few particulars respecting a voyage which I made to Spitsbergen in the year 1780, extracted from a journal I kept at the time; which you may lay before your readers, if you think they can contribute either to their information or amusement.

The Editor of the Philosophical Magazine. I am, &c. S. BACSTROM.

A voyage to Greenland, as it is called, though in fact to the island of Spitsbergen, for the purpose of killing the black whale-fish, is one of the healthiest that can be undertaken, and furnishes so much curious matter for amusement to persons of an inquisitive turn of mind, that even a second will hardly satisfy such, if they have been fortunate enough to

to ſail with a good commander, and in a veſſel well appointed. In both theſe reſpects I was very fortunate, which is rather uncommon; the maſters or commanders in the Greenland trade being generally men of little or no education, and conſequently void of thoſe liberal ſentiments neceſſary to render the ſituation of thoſe who accompany them comfortable. If a regularly educated ſurgeon, from a deſire of viſiting ſuch northern regions, goes in a veſſel under ſuch a perſon as I have deſcribed, he is generally ſickened the firſt voyage; a barber is perhaps his ſucceſſor, and when any illneſs or accident happens on board, if the patient eſcapes with his life, he is often rendered a cripple. I have ſeen ſome inſtances of this kind.

The unſociable diſpoſition of the maſter is not, however, the only circumſtance that often deters from a ſecond voyage. I have known veſſels well ſtored by the owners with every neceſſary and uſeful article, and even a liberal ſupply of what ſome would call luxuries, and yet every comfort withheld from thoſe on board: the maſter literally ſtarving himſelf and officers, and not allowing a bit of fire in the cabin, in theſe cold latitudes, that he might ſave a few coals, ſome dozens of hams and tongues, a quantity of cheeſe, butter, flour, wine, porter, &c. *to ſend home to his own family* at the end of the voyage: a paultry theft, at the expence of the health and froſt-bitten limbs of thoſe on board.

When the reader is informed that ſuch has been my paſſion to viſit foreign climes that I have been no leſs than fifteen voyages, one of them round the world, he will not be ſurpriſed that I ſhould wiſh to gratify my curioſity by viſiting the frozen regions, even though I knew ſomething of the inconveniencies before deſcribed, to which thoſe who undertake the voyage are often expoſed. My buſineſs was to guard againſt them as well as poſſible, by proper inquiries reſpecting the character and diſpoſition of the maſter, and I ſucceeded to my wiſh in two voyages to theſe parts: the firſt was in the Sea Horſe in the year 1779, which yielded me much

much ſatisfaction; but I was more completely gratified by the ſecond, which is the one I mean to deſcribe.

I engaged myſelf as ſurgeon on board the Riſing Sun, William Souter maſter, a well-appointed ſtout ſhip of 400 tons burthen, in the employ of Mr. William Ward. The veſſel carried about 90 men, and had 20 nine-pounders mounted on the main-deck, with nine whale-boats, ſome of them hung in the tackles over the ſides, and others ſtowed and laſhed on the deck.

We ſailed from London in the latter end of March 1780, and, as is uſual with Greenlandmen, called at the town of Larwick, the capital of the Shetland iſles, where we found a moſt hoſpitable reception. A Mr. Innes, the moſt opulent inhabitant of that country, kept an open table for every maſter of a veſſel and his ſurgeon; and no language can convey a proper idea of the kind and diſintereſted manner in which he received and entertained his gueſts. We lay there fourteen days wind bound. The country has a bleak barren appearance, the ſurface being generally rocky, or covered with turf, which is the fuel employed there; but the benevolence and hoſpitality of the more opulent, and the decency, ſobriety, and good conduct of all the inhabitants, even thoſe of the loweſt claſs, more than compenſate for the barrenneſs of the ſoil.

Proviſions of every kind, the finer vegetables and fruit excepted, are very abundant here, and extremely reaſonable. The price of a good fowl was threepence, of a dozen of new-laid eggs one penny; and as much excellent fiſh, cod, haddock, halibut, mackerel, &c. could be bought for one ſhilling, as would coſt at leaſt ten pounds at Billingſgate, or as uſed to dine our whole ſhip's company and the cabin. Potatoes, turnips, &c. are not more common there than peaches and apricots in England. Wheat flour is alſo a rare article, but the inhabitants in general prefer bread made of oatmeal.

The town of Larwick conſiſts of about 200 houſes, of one, or at moſt of two ſtories, which form a narrow crooked lane

on the sea side, badly paved with flat stones. All the houses are built of quarry stone: those of the rich are roomy, strong, convenient, and well furnished; those of the poor are small, and very smoky, for want of a proper arrangement of the chimneys.

Though the place lies in 60° north latitude, the winters are not severe; they are, however, wet and stormy. The harbour is very capacious and safe, and the anchoring ground good. About twenty or more English Greenlandmen were lying here at anchor, and several Dutch herring-busses. Having filled our empty water-casks, and laid in a stock of fowls, eggs, geneva, &c., we took leave of our kind friends on shore, and, the wind being southerly, hove up our anchor and set sail for the ice.

As we advanced to the northward the night became shorter till we came near North Cape in lat. 71° 10′, when we had no night at all. We were overtaken in that latitude by a most tremendous gale of wind from the north-east, which lasted three days and nights. Our ship lay more than once on her beam-ends, and every one on board thought she could never right again; but providentially we weathered the gale. A storm in those high latitudes is so intensely cold, when it blows from the north or north-east, that it is impossible to look in the wind's eye, as the cold is such as literally to tear the skin off the face.

In about 76° northern latitude we meet with ice floating in small round cakes, by the sailors called pancakes: you sail through this ice in perfectly smooth water; which, from being of a green colour in the North Sea, blue to the northward of Shetland and Ferro, grows gradually of a darker colour, and looks now of a deep black dye. We sailed several days through those floating ice-cakes. When in a still higher latitude, an open black-looking water re-appears; and when you reach about 77° or 78° you pass through large masses of floating ice 20 or 30 fathom thick, and some of them five or six times bigger than your own vessel. Great

care is taken to avoid ſtriking againſt thoſe maſſes, which ſometimes are ſo cloſe that there remains only a narrow channel for the ſhip to ſail through. I have ſeen this continue for 24 hours or longer. When this is the caſe, the commander ſtands in the main or fore-top, and ſometimes higher, and calls down to the men at the wheel how to ſteer. This navigation is attended with great danger, as the ice projects under water ſometimes two or three fathoms.

After navigating through thoſe floating maſſes, we ſaw the land of Spitſbergen eaſt from us. It is ſeen at an almoſt incredible diſtance, ſometimes at thirty leagues; a proof of its immenſe height. It generally appears amazingly bright, of the colour of the full moon; while the ſky above it looks white and cold.

In 79° and 80° you are prevented from going further to the northward by a ſolid continent of ice, or a collection of ice-fields, as they are called; ſome of which are many miles in extent. You make the ſhip faſt there with an ice anchor, and look out for whales, having two or three boats on the watch conſtantly.

No ſhip could ever poſſibly navigate through the huge maſſes of ice, which muſt neceſſarily be paſſed before it can reach this high latitude, but for a circumſtance which would on firſt view be little expected—The ſea there is always as perfectly ſmooth as the River Thames: the irregularly diſpoſed maſſes of ice prevent the water from ever acquiring, by the impulſe of the wind, thoſe regular undulations, if I may uſe the term, which, by long continuance of the ſame impulſe, would otherwiſe at laſt raiſe it in billows.

As ſoon as we got into ſmooth water, perhaps forty or fifty leagues from the land, the ſevere climate and intenſe cold we had experienced on the paſſage in a more ſouthern latitude before we made the ice, changed into a much milder one; and when it was fine weather it was quite warm, ſo that the icicles that hung from the large maſſes of

ice

ice diſſolved and kept dropping till a return of colder weather. Among the fields of ice, but more ſo in the harbours, it is conſiderably warmer than on the paſſage near North Cape.

In the month of June we killed ſeven large whale fiſh, and went with them into Magdalena Bay, to cut the blubber up into ſmall bits to fill the blubber-butts; which buſineſs is called *making off*. As the killing of the whales has been very well deſcribed by Zorgdrager and others, I need not deſcribe it.

When you approach a harbour on the coaſt of Spitſbergen, and, judging by the eye, expect to get in and come to anchor in three or four hours time, you are perhaps not leſs than ten or twelve leagues from it. This deception is owing to the immenſe heights of the rocky mountains, covered with ſnow, and bordered with ice towards the ſea-ſide, which make very large harbours appear like ſmall baſons, and the largeſt ſhips, when cloſe under them, like a boat on the Thames. Magdalena Bay, in 79° north, is capacious enough to hold the whole Britiſh navy; but, on account of the immenſe mountains which ſurround it, appears like a very ſmall inlet. We came to anchor in this bay, where we lay three weeks. While the people were making off, the maſters, ſurgeons, &c. of the different veſſels then there viſited each other, and diverted themſelves in the beſt way they were able. Such viſits laſt ſometimes 24 hours, for there is no night to interrupt the entertainment.

The firſt thing that ſtrikes a curious mind here is that ſolemn ſilence which reigns around; ſometimes interrupted with a noiſe, like thunder heard at a diſtance, occaſioned by huge fragments of ice and rocks rolling down from the immenſe ſteeps into the ſea.

I attempted to aſcend one of theſe mountains called Roche Hill. I got up about half way, which took ſeveral hours hard labour. At that height I found the rocks covered with birds eggs of different ſizes.

There

There are ſeveral rivulets and waterfalls of excellent water ſupplied by the melting of the ſnow. I met frequently with ſcurvy-graſs, wild celery, endive, water-creſſes, and a few other plants and flowers; though the general vegetation which covers the rocks conſiſts in various kinds of moſſes and ferns. There are white bears of an enormous ſize, white foxes, deer, and elks; and above twenty different ſorts of water and land birds; ſuch as, wild geeſe, wild ducks, ſea-parrots, roches, ſea-gulls, mallemooks as the ſailors call them, whoſe quills make the beſt drawing pens I ever met with, wild pigeons, the white duck with a beautiful ſcarlet head and yellow legs, and the ſnow-bird, whoſe note is as pleaſing as that of the bullfinch or nightingale.

This ſeaſon was the fineſt ever remembered in thoſe high latitudes, and we had almoſt conſtant fine weather. As we had room yet on board, and the ſeaſon was not too far advanced, in hopes of killing a fiſh or two more, we left Magdalena Bay and ſteered north. When we arrived in 80° we found a perfectly clear ocean free from ice, but ſaw no whales.

We continued puſhing to the northward with fine ſoutherly breezes and moſt beautiful weather, and could, with a good teleſcope, diſcover no ice to the northward, from the main-top-maſt head, but a ſolid continent of ice eaſt and weſt; ſo that we were in a kind of channel of perhaps three or four leagues wide. We kept puſhing on, the captain and I joking together about paſſing through the pole.

Both Captain Souter and myſelf found ourſelves at length ſome minutes north of 82°, where perhaps no man before us had ever been, nor ſince. The high ſnowy mountains of North Bank, or North Foreland, appeared very luminous, and bore ſouth on the compaſs.

We had a ſtrong inclination to puſh ſtill further north; but the danger of the eaſt and weſt ice, now to the ſouthward of us as well as to the northward, moving and locking us in, in which caſe we muſt have been beſet and inevitably

loſt, created a prudent fear, and induced the maſter to put about ſhip for North Foreland. The wind ſhifted at the ſame time to the northward, and in a couple of days we came to anchor on North Bank, called Smeerenburg's Harbour. We ſaw now plenty of fin-fiſh or finners, white whales, and unicorns; which is a ſign that the ſeaſon is over for killing the black whale, which then retires to the northward. As all theſe animals are well known and deſcribed, I forbear ſaying any thing reſpecting them.

One of our men having been at the habitation of the Ruſſians in North Bank the year before, and aſſuring us that he could find the way to their hut, Captain Souter, a man of an inquiſitive mind, propoſed to me to pay them a viſit. We took ten or twelve men with us, a compaſs, a few bottles of wine, bread, cheeſe, &c., and ſome good trade-knives, with a ſmall keg of gunpowder, to make a preſent of to the Ruſſians.

We landed at the bottom of the harbour to the eaſtward, where we found a large valley, ſeveral miles in breadth, ſurrounded with immenſe high mountains, moſtly covered with ſnow; but as the ſun had melted a part, the brown and black rock appeared, and rivulets of clear water ran down, forming little waterfalls.

The ground was turf and clay, and not bad to walk on: we had ſeveral ſmall rivulets to croſs, of two or three feet wide, but very ſhallow; near them we found ſcurvy-graſs, water-creſſes, endive, wild celery, and a few ſmall flowers, and ſaw a number of land birds flying up at our approach. We croſſed a piece of ground where the Dutch had formerly buried their dead: three or four of the coffins were open, with human ſkeletons lying in them. Some inſcriptions on boards, of which above twenty were erected over the graves, had the years 1630, 1640, &c. affixed to them. We alſo ſaw the ruins of ſome brickwork, which had been a furnace, as the Dutch uſed to boil their oil here in the laſt century, and for that reaſon called it Smeerenburg's Haven, or

the Harbour of the Fat Borough. We had above ſix miles to walk to the northward, and were very much fatigued on account of the unevenneſs of the ground and the heat, when we diſcovered the hut of the Ruſſians at a diſtance. They perceived our approach, and ſent two or three people to meet and welcome us.

The common men made a ſtrange appearance; they looked very much like ſome Jews in Rag Fair or Roſemary-Lane: they wore long beards, fur caps on their heads, brown ſheep-ſkin jackets with the wool outſide, boots, and long knives at their ſides by way of hangers. When we arrived at the hut, we were preſented to the caravelſk or commander, and to the ſurgeon, who both received us very politely, and invited us into the houſe, where we ſat down to reſt and refreſh ourſelves. Our people were introduced to their people in an outer room, and were entertained with meat and brandy. It happened fortunately that the ſurgeon was a German, a native of Berlin, of the name of Iderich Pochenthal, conſequently I could converſe with him; and we both acted as interpreters between his and our commander.

Captain Souter began with offering to the Ruſſian commander, (who was alſo dreſſed in furs, only of a finer ſort, and wore his beard and whiſkers like the common men,) the keg of gunpowder and half a dozen of good table knives and forks: the Ruſſian captain accepted them with a great deal of joy, and made us a preſent in return, conſiſting of half a dozen of white fox ſkins, two brown loaves of rye bread, ſix ſmoked rein-deer tongues, and two rib-pieces of ſmoked deer, for which we kindly thanked him. They turned out to be moſt excellent eating, and of a finer flavour than any Engliſh ſmoked tongues, or hung beef.

We placed our wine on the table, our bread and cheeſe, and the Ruſſian captain ordered boiled ſmoked rein-deer tongues, new rye bread, and good brandy and water to be brought in. We all made a hearty, ſociable meal; the tongues, and the rye bread, which was new and ſavory, were

 a rarity

a rarity to us; the Ruſſian officers reliſhed our Cheſhire cheeſe and ſhip's biſcuit as a very high treat. We drank the Empreſs of Ruſſia's and King George's health. The Ruſſian commander was an elderly man, of very agreeable manners; the ſurgeon extremely ſo, and very intelligent.

The hut conſiſted of two large rooms, each about 30 feet ſquare, but ſo low that I touched the ceiling with my fur cap. In the middle of the front-room was a circular erection of brick-work, which ſerved as an oven to bake their bread, and bake or boil their meat, and at the ſame time performed the office of a ſtove to warm the room. The fuel employed was wood, which drives on ſhore plentifully in whole trees ſtripped of their branches. A chimney carried the ſmoke out of the roof of the hut; but when they wiſhed it, they could, by means of a flue, convey the ſmoke into the back room for the purpoſe of ſmoking and curing their rein-deer fleſh and tongues, bears hams, &c. Round three ſides of the front room was raiſed an elevated place of about three feet wide, covered with white bear ſkins, which ſerved for bedſteads. The captain's bed-clothes were made of white fox ſkins ſewed together; the ſurgeon's was the ſame: the boatſwain, cook, carpenter, and the men, had ſheep-ſkins. The walls inſide the room were very ſmooth and white-waſhed; and the ceiling was made of ſtout deal-boards, plained ſmooth, and white-waſhed.

The rooms had a ſufficient number of ſmall glaſs windows, of about two feet ſquare, to afford light: the floor was hard clay, perfectly ſmooth: the whole hut was nearly 60 feet in length, and 34 wide outſide; and was conſtructed of heavy beams cut ſquare, of about twelve inches thick, laid horizontally one upon the other, joined at the four corners by a kind of dove-tailing, caulked with dry moſs, and payed over with tar and pitch, ſo that not a breath of air can penetrate: the roof conſiſted of thin ribs laid acroſs the beam-walls, and three-inch deal nailed over them, ſo that you could walk on the top of the houſe: the roof was caulked and tarred,

tarred, and perfectly tight. This is the manner of building houses in the country in Russia, particularly about Archangel.

The surgeon gave me the following account of this Russian colony in Smeerenburg's Harbour:

Some associated merchants at Archangel fit out a crabbla, or vessel, every year, of about 100 tons, with a commander, mate, surgeon, boatswain, carpenter, cook, and about fifteen hands, well provided with muskets, powder and shot, good large knives, and all kinds of utensils for killing whales, unicorns, rein-deer, bears, and foxes.

With a sufficient stock of rye-flour, brandy, clothing, snow shoes, deal boards, carpenters tools, &c. this vessel sails every year in the month of May from Archangel, goes round the North Cape of Norway, and arrives in June or July at Smeerenburg's Harbour, where the new colony is left on shore. The vessel stays two or three weeks in the harbour to refit, and carries the old colony with their cargo (consisting of whales' blubber, blades or so called whalebone, white bear skins, white fox skins, eiderdown and feathers, unicorns' trunks, which is an ivory that never turns yellow, and smoked rein-deers' tongues,) home to Archangel. The colonists have no wages, but receive thousandth shares for what they bring home: the captain has fifty shares, the mate and surgeon thirty each; the carpenter, boatswain, and cook, ten each; and each common man or boy has one share. The surgeon told me that the captain had above 1000 rubles due to him, and he himself about 600, and each common man perhaps 50 or 60: that when they returned safe home, the common men would be able to live a whole year upon their money, and the officers much longer, as the necessaries of life were very cheap at Archangel; and for the Company it had hitherto answered extremely well.

He told me this was his second trip, so well had it answered his expectations. "During the so called long nights," said he, "it seldom or never is so dark that you cannot see before you, nor is it so dreadfully cold as it is at Petersburg

every winter. When a ſnow ſtorm happens, we cannot go out of the houſe; but when it is ſerene, and no wind, it is not too cold to go out and walk many miles. With the moonlight, the uncommon brilliancy of the ſtars in theſe high latitudes, and the reflection of the northern lights, or *aurora borealis*, we have ſo much light that we can ſee to read a book or to write.

" In winter time the black whales come into the harbour and play cloſe within ſhore, where we kill now and then one with harpoons fired out of a ſwivel. We kill white bears, foxes, rein-deer, and birds, as many as we can before the night-ſeaſon, which commences in September, when all the land animals leave us and walk over the ice into Nova Zembla and Siberia: the land birds leave us in the ſame manner. Unicorns we alſo kill in the harbour, for the ſake of their ivory trunks, which are afterwards ſent to Germany and France."

The ſurgeon and I had a race on ſnow ſhoes, which are a kind of ſkates, of about two feet in length, for ſkating over the ſnow and ice. As I was in former years a good ſkater, I could uſe them as well as he did. We ran ſix or ſeven miles with them in an hour without fatiguing ourſelves: they have no irons.

Before we left our Ruſſian hoſt, he informed us, that a few weeks before they had, coming home from a ſhooting party, found an Engliſh captain and nine or ten men overhauling their property in the hut. The captain, finding that his cheſt had been broke open, and that his rubles were diminiſhed conſiderably, reproached the Engliſh commander with the robbery, and a battle enſued. " The Engliſh fired upon us," ſaid the ſurgeon, who acted all along as interpreter, " and killed one of our men on the ſpot. We returned the fire and wounded ſome of his men, and cauſed them to retreat precipitately. When the Engliſh were gone, our captain counted his rubles, and found that there were 600 miſſing." He intended to ſend a ſtatement of the affair to the Ruſſian government.

After

After having ſtaid above twelve hours with the Ruſſians, highly entertained, we invited them to come to ſee us on board and took our leave, returning the ſame way by the compaſs, and arrived ſafe on board, after having been abſent almoſt eighteen hours.

We now prepared for the voyage home; and, after having filled our empty caſks with good water from the ſhore, and made a clear ſhip, we ſet ſail with a fine north-eaſterly breeze in the middle of July 1780. We ſailed again through a great quantity of floating ice, and, our ſhip being a good ſailer, paſſed ſeveral full ſhips bound homewards.

The firſt pleaſing change we experienced was to have ſome night, and to be obliged to light a candle in the cabin. O what a luxury!—When you have no darkneſs for a conſiderable time (during May, June, and July), light becomes tedious at laſt; and the firſt time you ſee a candle burning in the cabin, and a dark night, the pleaſure is indeſcribable. Before we came into this more ſouthern latitude, I uſed to obſerve the ſetting of the ſun, reſting, as it were, on the horizon, appearing of a very large ſize, ſurrounded with moſt beautiful and glorious colours of various tints, and then the riſing of it ſhortly after in full majeſty. Language cannot convey an idea of the ſcene.

We came to anchor at Larwick towards the end of July, and were received in the kindeſt manner by Mr. Innes and all our friends in the place.

After three weeks ſtay we took leave of our Shetland friends, and ſailed in company with a number of full ſhips for England. When we came on the coaſt of Northumberland and Yorkſhire, the breeze and weather being favourable, we were delighted with the ſmell of the hay from the ſhore, and the ſight of the pretty little towns and villages built on the ſea-ſide, and refreſhed with excellent freſh cod and haddock, which the Yorkſhire cobles (a kind of fiſhing boats) bring on board; in return for which they prefer taking a piece of beef or pork to money: they bring ſome-

 times

times eggs, potatoes, &c. We had an uncommonly pleaſant voyage home, and conſtant fine weather, accompanied with northerly breezes.

We arrived about the latter end of Auguſt ſafe in Greenland Dock, after having been out five months.

Captain Souter kept an excellent table in the cabin, and a conſtant fire in the ſtove: his ſtudy was to make every perſon on board comfortable. In the fifteen voyages I have been to ſea, I have only twice had the good fortune to ſail with men of equal worth; Mr. Charles Patterſon of the Sea Horſe, and Mr. William Alder, now a Lieutenant in the Britiſh Navy.

VI. *An Attempt to arrange the Cryſtals of Oxidated Tin Ore, according to their ſuppoſed Structure. By* Mr. William Day, *Leiceſter Place. Communicated by the Author.*

The cryſtalliſations of oxidated tin ore are deſcribed by Romé de l'Iſle, in his Criſtallography, to be of the octaedral form and its modifications; the octaedra having iſoſceles triangular faces, inclined at an angle of 45° to the baſe of each pyramid; ſo that the junction of their baſes and apices are right angles. In the following arrangement the octaedron is conſidered as the primitive form, and the modifications as being produced by an accumulation, on its faces, of laminæ compoſed of ſimilar minute moleculæ, experiencing different laws of decrement on their ſides or angles, or on both. Theſe laws of decrement are marked with the ſigns invented by Hauy, of which an account has been given in the Phil. Mag. Vol. II. p. 398. The greater part of theſe forms having been very accurately deſcribed by De l'Iſle, all that is now attempted is an application of Hauy's ſyſtem to the arrangement of this part of a private cabinet of Engliſh minerals; nor would it have been made public but for the repeated ſolicitations of ſeveral friends.

In

In the annexed drawing (ſee plate III.) all the plans, and alſo the figures marked 1 *a*, 1 *b*, and 1 *c*, are geometrical: the others are drawings from models, and in perſpective as they appear to the eye; but all of them placed in the ſame relative ſituation to the nucleus, fig. 1., on which they are ſuppoſed to be formed. Mathematical correctneſs is not attempted, nor is it neceſſary. The priſms are ſhewn with the pyramid on one end only; not on both, as in De l'Iſle's plates.

Fig. 1, a perſpective view of the primitive octaedron of oxidated tin ore. 1 *a*, a front geometrical elevation, with the quantity of the angles marked upon them. 1 *b*, an angular geometrical elevation, alſo with the quantity of the angles marked upon them. 1 *c*, one of the faces of the octaedron, ſubdivided to ſhew the ſuppoſed arrangement of the primitive moleculæ that form one lamina. The dark triangles repreſent the ſpaces they occupy reſpectively, and the difference of ſhading, the progreſs of diminution by a ſubtraction of one range of moleculæ on the edges of the faces, according to the third law of decrement. The ſuperior angle A of this face is 70°, the two inferior angles E, E, 55° each. The letters on the three geometrical figures mark the ſame ſituations on all of them, and are thoſe employed by Hauy to indicate the laws of decrement.

As Hauy's *ſyſtem* has been given in the Firſt Volume of the Philoſophical Magazine, and his *ſigns* in the Second, little more is required here but to give the ſign to which the figures belong.

Firſt Law of Decrement $\overset{1}{\underset{1}{D}}$.

To this law belong fig. 2, 3, and 4. Fig. 2 *a*, without the dotted lines, would repreſent a plan of fig. 2. That portion of fig. 2 *a*, included between the dotted lines *b b*, *b b*, repreſents a plan of fig. 3. The plan of fig. 4 is evident from the figure.

Second Law of Decrement $^{1}E^{1}$.

Fig. 5 belongs to this law: fig. 2 *a*, the angles being taken off at the dotted lines, repreſents a plan of it. Fig. 6 is a

combination of this law with another not yet determined, making the priſm ſixteen-ſided: fig. 6 *a* is the plan.

Third Law of Decrement $B^{1}\overset{1}{\underset{1}{D}}{}^{1}B$.

Fig. 7 ſhews it incomplete. The plan is ſhewn, fig. 22 *a*, including the dotted lines. Fig. 8, the completion of this law: 8 *a* is the plan. Fig. 22 is an irregular formation, by this law taking place unequally: 22 *a*, (without the portion expreſſed by the dotted lines,) is the plan. The plans of two other unequal accumulations, which diſguiſe the pyramid, are ſhewn fig. 7 *a*, 7 *b*. Fig. 21, the ſame as fig. 8, become cuneiform: 21 *a*, the plan.

Fourth Law of Decrement $\underset{1}{A}$.

Fig. 9 ſhews the combination with the firſt law: fig. 10, the ſame with the third law, incomplete: fig. 11, the laſt completed: fig. 12, the combination with the firſt and ſecond laws: this, and the combination with the firſt law only, are in general peculiar to Bohemian and Saxon ores; the Engliſh ores exhibit but few examples of them. I have an Engliſh cryſtal ſimilar to fig. 9, and it is the only one I have ſeen. Fig. 13, the combination with the ſecond and third law: fig. 13 *a* is the plan.

Fifth Law of Decrement $^{2}E^{2}\overset{1}{\underset{1}{D}}$.

Fig. 14, the firſt indication of this law, in combination with the third law, incomplete. Fig. 15, this law farther extended in the ſame combination: 15 *a*, the plan. Fig. 16, a further extenſion, but ſtill incomplete: fig. 16 *a*, the plan. Fig. 17, the completion of this decrement: fig. 17 *a*, the plan. Fig. 18, the combination of this law, when arrived at the ſtage ſhewn in fig. 16, with the third law. Compare fig. 15 and 18. Fig. 19 and 20 are the ſame as fig. 16, with ſome irregularity in the formation.

Theſe five laws of decrement embrace all the varieties of facets I have yet obſerved (except thoſe mentioned when ſpeaking of fig. 6); and by combination, in different ſtages of

of each reſpectively, produce a great variety of forms, while other varieties ariſe from difference in colour and tranſparency to which all theſe cryſtalliſations are ſubject.

The macles of De l'Iſle, which Hauy has called *hemitrope*, or half-turned, may be added as a ſupplementary claſs. Of the term *macle*, De l'Iſle gives this explanation: "When in any cryſtal whatever one or more re-entering or internal angles are obſerved, we may conclude that it is not a ſimple cryſtal, but a group of two or more; or even two turned or reverſed moieties of the ſame cryſtal." De l'Iſle was indebted to a Mr. Lermina for determining the direction of the ſection which produced the hemitrope cryſtals of tin, which he has ſhewn to be parallel to two oppoſite edges of the octaedron. Imagine the primitive octaedron to be divided into halves by a plane paſſing diagonally through it, from the centre B, fig. 24, of one of the edges of the ſuperior pyramid, to the centre B of that edge of the inferior pyramid which is diagonally oppoſite; the plane will paſs through two oppoſite angles FE of the baſe, dividing on each pyramid two adjoining faces into four ſcalene triangles, and leaving two adjoining faces perfect, but reverſed on one pyramid in reſpect to the other. The plane FBEB' of this ſection is a rhomb of 60° and 120°.

The priſmatic cryſtals appear to be as ſuſceptible of that ſpecies of accumulation which produces the hemitrope as the octaedron, and the ſection is always parallel to the one determined above. If the priſm is ſhort, and terminated by two pyramids, the ſection will paſs through the priſm into both pyramids, and be irregularly octagon; but if the priſm is long enough to permit the ſection to paſs through it without encroaching on the pyramids, it will be a rhomb of 70° and 110°; the ſame as the ſection of the primitive octaedron, perpendicular from the apex, and diagonally acroſs the baſe.

I have ſome cryſtals which are produced by a double ſection, and both ends turned on the middle part; others which appear to be only portions taken off the angles at the junctions

tions of the pyramids to the prifm, and reverfed together without the intermediate part. In fact, the varieties appear to be almoft innumerable.

After I had made the above arrangement, I received the 32d Number of the *Journal des Mines*, from which I beg leave to fubjoin the following extracts:

" The primitive form of the cryftals of oxydated tin appeared to me to be that of a cube performing the function of a parallelopipedon; fo that the decrements which produce the fecondary forms have, in regard to the two oppofite faces of the cube, which muft be confidered as the bafes, an action different from that which takes place in regard to the other four faces that reprefent the planes of the prifm." (p. 576.)

" One of the rareft varieties of this kind is that reprefented fig. 7 *, and which is the feventh of Romé de Lifle, T. III. p. 422. We give it the name of *diftique* oxyd of tin; that is to fay, with two ranges of facets. It has altogether thirty-fix faces; four of which M M are vertical, and on each fide eight inferior oblique z, z', and eight fuperior oblique o, s. If, as ufual, we denote the edges of the bafe of the cubic nucleus by B, and the angles by A, we fhall have, as the indicating fign of this variety, M $(\overset{\frac{1}{3}}{A}\, B^2\, B^3)\ \overset{1}{B}\ \overset{2}{A}$, in which the intermediary decrement is referred to the facets z, z', the decrement $\overset{1}{B}$ to the facets s, s, and the decrement $\overset{2}{A}$ to the facets o, o. The following is the indication of the principal angles: incidence of M to M 90°, of z to z 116° 20′, of z to z' 158° 30′, of s to s 120°, of o to s 150°. Quantity of the angle n 118° 4′." (*Suite de l'Extrait du Traité de Mineralogie de* C. Hauy, p. 578.)

From the preceding extracts it appears that Hauy has fuppofed the cube to be the nucleus or primitive form of the oxidated tin cryftals. I have again carefully examined the cryftals in my own collection, and, according to the indi-

* Fig. 23 is a tracing from Hauy's fig. 7, referred to here, and is the fame cryftal as reprefented fig. 18.

cations

cations obſerved on them, from which I have formed my arrangement agreeably to the law laid down by Hauy himſelf, (ſee Phil. Mag. Vol. I. p. 292.) I ſee no reaſon at preſent why I ſhould alter it. The cryſtals of oxidated tin are in general ſo hard and brittle that I have not been able to ſeparate the laminæ; and there is nothing to guide the obſerver but the direction of the ſtriæ on the ſecondary facets. Now the faces, which are parallel to the faces of the octaedron before mentioned, are always very brilliant; but thoſe which are on a plane with the edges are ſtriated parallel to thoſe edges, particularly thoſe cryſtals which ſhew the intermediate ſtages of the third law. If the nucleus were a cube, and the laminæ accumulated on it, to form the ſecondary cryſtals, ſhewed their direction by ſtriæ on the new facets, thoſe ſtriæ would be in a direction quite contrary to what are ſhewn on theſe cryſtals: inſtead of going the length of the new facets parallel to the edges of the octaedron, they would croſs the facets perpendicularly to their preſent direction, and it would be impoſſible for the cryſtal fig. 7 to take the form of fig. 8. In my collection there is a group of opaque black cryſtals, ſhewing all the variations from the primitive priſmatic cryſtal fig. 2, to the completion of the third law of decrement fig. 8. In all of them the direction of the ſtriæ is very evident. The Saxon and Bohemian ores of tin are moſt common in the cabinets of France: the cryſtals are larger, but do not preſent the varieties of forms that Engliſh ores do; being moſtly confined to the octaedron and its hemitrope, and thoſe variations of the fourth law which approach the cube. Had Hauy ſeen a greater number of the varieties of the Engliſh tin ores, I think he would, for the primitive form, have had recourſe to the octaedron, which, by a very ſimple law of decrement, produces the cube and its varieties that occur in the tin cryſtalliſations.

To theſe obſervations may be added De l'Iſle's deſcription of the ſame cryſtal that Hauy has deſcribed (above), which I find

I find to agree ſo well with what I have obſerved in nature, that I am inclined to ſuppoſe Haüy's meaſures of the angles are given from calculation, aſſuming the cube as the nucleus, and not from meaſurement on the cryſtal. De l'Iſle's deſcription is as follows:

"It is a blackiſh kind of tin ore, in ſmall ſolitary cryſtals five or ſix lines in length, and at moſt three in breadth. In the variety in queſtion, one of the extremities of the rectangular tetraedral priſm firſt preſents an octaedral pyramid, the planes of which forming with the priſm an angle of 155° are irregular pentagons, having one of their angles of 60°, two of 120°, one of 110°, and the moſt obtuſe of 130°. Theſe pentagons form with each other angles of 110° and 160°. The pyramidal form thence reſulting is itſelf terminated by a tetraedral ſummit with trapezoidal planes joining at right angles, as is obſerved in the iſoſceles triangles of the third variety: but this ſummit becomes octaedral by the ſlight truncature of its edges, from which reſult four linear hexagons that form by their contact at the ſummit of the pyramid obtuſe angles of 110°. The planes of the priſm, had it not been broken, would be regular hexagons, and the whole cryſtal would then have thirty-ſix facets." *De l'Iſle's Cryſtallographie*, Tom. III. p. 423.

Having ſaid ſo much reſpecting the external form, a few remarks concerning the chemical analyſis of tin ores cannot be miſplaced in a paper like the preſent. On this part of the ſubject, I cannot do better than by quoting from a paper of C. Guyton, formerly and better known here by the name of De Morveau, whoſe chemical authority always carries great weight with it. In his paper entitled, *Obſervations on the Acid of Tin, and an Analyſis of its Ores*, after giving the analyſes of the brown tin ore of Schlackenwald, as publiſhed by Mr. Klaproth, which he verified himſelf, and found to contain, tin 75, iron 0·5, ſilex 0·75, and oxygen 23·75 = 100; he proceeds to give a reaſon why the tin cryſ-

tals

tals are ſo inſoluble in acids, and combats the idea of Klaproth, that it ariſes from ſuperſaturation by oxygen, which is diſſipated by fluxing the ore with vegetable alkali.

"I believed I had good reaſon," ſays he, "to doubt that the complete oxygenation, or (if the term be preferred) the ſuperſaturation by oxygen, was the true cauſe of its inſolubility in the muriatic acid; becauſe I could not, at any one inſtant of the operation, perceive either the ſubſtance that ſhould take it away, or any of the phenomena that would have accompanied its diſengagement. That I might with the greater facility obſerve all the circumſtances, I operated with a ſmall platina crucible over an Argand's lamp. Fifty-five centigrammes of brown cryſtals of tin were reduced to a fine powder, and mixed with ſix times as much pot-aſh (purified by alcohol, and dried): the mixture was moiſtened with a few drops of water. I evaporated it firſt to dryneſs, and then to a commencement of fuſion. After the firſt treatment, hot water poured on the maſs diſſolved more than half the mineral, which was then firſt precipitated from it by muriatic acid, and afterwards rediſſolved by it with the greateſt facility; and the precipitate of the metallic oxyde, reproduced by adding carbonat of pot-aſh, was found, as ſtated by Klaproth, completely ſoluble again by the ſame acid. After having myſelf witneſſed this fact, my firſt doubt on the direct cauſe of the inſolubility of this ore was rather ſtrengthened than removed. It cannot be ſaid that the exceſs of oxygen eſcaped during the fuſion with the pot-aſh; for the metal could not form a ſoluble combination with alkali, unleſs it was oxidated in the higheſt degree; or, more properly, in the ſtate of an acid, ſo as that the ſolution filtered from the reſidue ſhould be a true ſtannate, or (if the term be preferred) ſtannite of tin*.

"Now, if we are obliged to admit that *all the oxygen* of the ore is again found in the alkaline ſolution, it cannot be the loſs of *a part* of that principle that renders the metal

* The author muſt have written Stannite of pot-aſh. D.

more

more ſoluble in the acid, for it is ſtill found in the ſame ſtate of ſaturation: beſides, it does not exhibit any ſigns of the oxygenated muriatic acid gas; and in this caſe it is difficult to conceive why there ſhould not rather be a diſengagement of this gas at the time of digeſtion of the acid on the ore, as happens with the oxydes of mangancſe and lead.

"To eſtabliſh this point of theory on a deciſive experiment, I diſſolved ſix grammes of tin in nitrous acid, which I evaporated ſeveral times to dryneſs, adding each time freſh acid. I think it cannot be doubted that in this ſtate the tin had taken all the oxygen it was capable of fixing; yet the maſs of white oxyd, waſhed till the water that came from it did not in the leaſt alter vegetable colours, was readily diſſolved in muriatic acid. What then is the cauſe of the inſolubility of the ore, which alſo is nothing but tin and oxygen, containing hardly 0·01 of extraneous matter? The cauſe can only be found in the ſtate of aggregation of the latter. This aſſertion ought not to excite ſurpriſe, for hitherto ſufficient account has not been taken of this power. If combinations are the reſult of affinity or elective attraction, this attraction itſelf is nothing but a power which may be rendered ineffectual by the ſum of the forces which counteract it. Theſe truths ſurely will not be denied by Mr. Klaproth, who has rendered them ſo palpable, by ſhewing us that the ruby, the ſapphire, the adamantine ſpar, the elements of which were naturally eaſily ſoluble, reſiſted the ordinary means of analyſis only by the ſtate of the aggregation of their integral parts."

De l'Iſle, whoſe ſecond edition was publſhed in 1783, conjectured what Guyton here advances from experiment. His words are as follow:—"I cannot agree with Mr. Bergman, that there is no mineralizing ſubſtance in the cryſtals of tin, becauſe, in default of ſulphur or arſenic, we ought at leaſt to find *the acid principle*, by the aid of which the metallic earth of tin takes a conſtant and determinate cryſtalline form."

VII. *On*

VII. *Experiments respecting the Effects of Quickfilver on Vegetable Life.* *By* VON DEIMANN, PAATS VAN TROSTWYK and LAUWERENBURGH *.

EXPER. I. A plant of the fmall garden bean, which had grown in the open fields, was placed in water clofe to a flafk filled with quickfilver one inch in diameter, and the water was covered by a bell twelve inches in height and fix in diameter.

II. A plant of curled mint, the root of which ftood in water, was placed with quickfilver under a bell eight inches in height and four and a half in diameter.

III. The firft experiment was repeated, with this variation; that the bell, inftead of ftanding over water, was placed on a difh, and fupported by pieces of cork.

IV. The fame experiment as the fecond, with this difference; that pieces of leaf gold were fufpended in the bell.

V. A flafk filled with quickfilver was placed clofe to fome young plants of the *fpiræa falicifolia*, which ftill adhered to the parent root, and the whole was covered with a bell.

VI. The fecond experiment was repeated, and a little fulphur was applied to the interior fides of the bell.

VII. The fecond experiment again repeated, with this difference; that the quickfilver was covered with a little water.

VIII. A plant of the curled mint was placed in a bafon of water with a little quickfilver, in fuch a manner that the roots were in contact with the metal.

IX. The roots of a bean plant, which had fhot out through holes made in the pot in which it had been reared, were placed in a flat difh filled with quickfilver.

X. Some beans were planted in earth mixed with quickfilver.

XI. A plant of the curled mint was placed in a bafon with water, and red oxyd of mercury prepared with the nitrous

* From Scherer's *Allgemeines Journal der Chemie*, Vol. I. No. 6.

nitrous acid which had been washed first with an alcaline solution and then with pure water, the roots being immersed in the oxyd.

XII. The same as the second, with this variation; that instead of quickfilver the oxyd was used.

XIII. Beans were planted in a mixture of earth and the red oxyd of quickfilver.

XIV. The same planted in earth mixed with the oxyd of lead.

XV. Of three plants of the curled mint, one was placed, in the same manner as in the 11th experiment, in a phial which contained water and the oxyd of manganese; the second in another, containing water and the oxyd of copper; and the third in one containing water and the oxyd of lead.

The leaves and stems in the experiments 1, 2, 3, 4, and 5, were on the third day covered with black spots; and on the fourth, fifth, and at most the sixth, had become entirely black. The young tree in the 5th experiment could not hold out the whole summer, though it stood connected with the parent plant. The plants died so completely that the leaves frequently dropped off, and the stem sunk down the very moment the bell was removed. The plants in the 6th experiment remained without any change, which shews that sulphur prevents the bad effects of the quickfilver. In the 7th experiment the effect of the quickfilver was destroyed, on account of the water by which it was covered.

The experiments 8, 9, and 10, prove that the quickfilver, when mixed with earth or water, or when it stands in contact with the roots of plants, is in no manner prejudicial to them.

The 11th experiment, which we repeated several times, shewed us that the oxyd of quickfilver, placed in contact with the roots of a plant, is destructive to it. This oxyd, however, did not produce the same effect when it was placed as the metallic quickfilver, near to the plant; as was proved by the 12th experiment, in which the plant did not experience the least change.

In

In the 15th experiment the plants were not in the leaſt affected by the different oxyds; which proves that plants, like animals, ſeem capable of being accuſtomed to things pernicious to them, provided they begin at infancy. The beans planted in earth mixed with the oxyd of quickſilver grew up, but ſo weak and ſtunted that they could ſcarcely be known. Thoſe, however, which had been planted at the ſame time as the former in a mixture of earth and the oxyd of lead, ſhot up as uſual, and exceeded them in ſtrength and weight more than four times.

In theſe reſearches we were at great pains to make ſome comparative experiments, and we found that the plants in thoſe where no quickſilver was employed, lived a conſiderable time in a ſtate of perfect vegetation. Theſe reſults we give merely as facts, without attempting at preſent to explain them. A conſiderable quantity of quickſilver placed in a very confined atmoſphere may be equally pernicious to animal exiſtence, as we think ourſelves authoriſed to infer from ſeveral experiments, the courſe of which the late ſeaſon of the year obliged us to ſuſpend, and from which it appears that, in one point of view, things hurtful to animals are hurtful alſo to plants.

VIII. *Obſervations on Animal Electricity; being the Subſtance of two Letters from* A. VOLTA *to* Profeſſor GREN.

[Concluded from Page 68.]

THE very conſiderable difference in regard to the quantity of effect in the before-mentioned experiments already ſhews, that if the electric ſtream excited by contact is ſtrongeſt towards a certain metal, when that metal is placed between a certain fluid on the one ſide, and another fluid on the other, there are other fluids which produce a greater effect with another kind of metal; ſo that it will be neceſſary to diſcover by experiment the particular arrangement of

conductors ſuited to each metal, in which the fluids or conductors of the ſecond claſs muſt be diſpoſed according to their activity. I have paid great attention to this circumſtance, and have formed ſeveral tables, which I ſhall publiſh as ſoon as I have brought them to perfection.

I ſhall here, however, only obſerve, that in order to claſs, in ſome manner, the innumerable different moiſt conductors of this kind, I diſtinguiſh them into aqueous, ſpiritous, mucous, and gelatinous, ſaccharine, ſaponaceous, ſaline, acid, alcaline, and ſulphurous (livers of ſulphur) liquids; that I make ſubdiviſions in the acids down to the beſt known ſimple mineral acids, (as I find in this reſpect great difference between the nitrous and the muriatic acids,) comprehending the principal vegetable acids and the acid of galls; and do the ſame in regard to the ſaline fluids, according as they are ſolutions of neutral ſalts, earthy ſalts, and particularly metallic ſalts.

When it can be determined in what order all theſe kinds of fluids follow each other, in regard to the power in queſtion, for the metal A, and another for the metal B, &c., we ſhall then be in a condition to determine what place muſt be aſſigned to a great number of other heterogeneous fluids, whether mineral, vegetable, or animal, which belong to ſeveral of the above claſſes. In general, the order for the greater part of the metals hitherto obſerved is as follows: 1ſt, pure water; 2d, water mixed with clay or chalk, (which ſhews a pretty different effect when the before-mentioned experiment is made with two glaſſes, a bow of tin or zinc, and a properly prepared frog, which has a ſufficient degree of vitality); 3d, a ſolution of ſugar; 4th, alcohol; 5th, milk; 6th, mucilaginous fluids; 7th, animal gelatinous fluids; 8th, wine; 9th, vinegar, and other vegetable juices and acids; 10th, ſaliva; 11th, mucus of the noſe; 12th, blood; 13th, brains; 14th, ſolution of ſalt; 15th, ſoap ſuds; 16th, chalk water; 17th, concentrated mineral acids; 18th, ſtrong alcaline leys; 19th, alcaline fluids; 20th, livers of ſulphur.

With

With ſome metals there is, however, a conſiderable deviation from this order, in regard to livers of ſulphur, alcaline fluids, and the nitrous and ſaline acids.

As to the metals, which in their poſition between theſe different fluids are more or leſs proper for the electric effect in queſtion, I have found in general that tin exceeds all others, and that ſilver is the worſt; except when one of the fluids betwixt which the ſilver is placed is water, or any other aqueous conductor, and the other liver of ſulphur: in this caſe ſilver far exceeds zinc, and even tin. Iron alſo produces a much greater effect than any other metal, when it is in contact, on the one ſide, with mere water or an aqueous conductor, and on the other with the nitrous acid, were it even only a drop. The excitement occaſioned in both caſes is wonderful; ſince it exceeds, as I have already remarked, that produced, according to the uſual method, by means of a double metallic bow, even of different metals, as zinc and ſilver, applied to conductors of the ſecond claſs of the ſame kind. It is ſufficiently ſtrong and powerful to produce convulſive movement in a half-prepared frog, the bowels of which have not been taken out, when one of the two moiſt conductors is a concentrated alcaline ſolution, and the metal placed between them is zinc, or rather tin. With other metals and other fluids you can ſeldom produce convulſions in a frog, if it be not perfectly prepared, or at leaſt embowelled.

The reader will readily perceive, that when a bow of one and the ſame metal touches with both its ends the ſame kind of ſaline water, the ſame acid, the ſame alcaline fluid, &c. an electric ſtream will not take place, as happens alſo when it touches on each ſide merely water: in that caſe two oppoſite actions are oppoſed to each other, and keep each other in equilibrium. That theſe contrary powers, however, may be in perfect equilibrium, it is neceſſary that the fluids applied to both ends of the homogeneous metalline bow be exactly of the ſame kind and of the ſame ſtrength. For this reaſon the

most careful attention and a certain dexterity are required in order to ensure success to the experiment, which I have often performed to the great astonishment of the spectators, and which any one may repeat as was done by my friend Humboldt. That philosopher has already published some of the most striking and decisive of these experiments in his second letter; and I shall here give a more particular account of them.

Having placed a completely or only half-prepared frog as usual in two glasses of water, take a very clean bow of silver (it will be best when it has been washed with water from the glasses), and immerse both ends of it at once, or the one after the other, in the glasses, no agitation of the frog will be occasioned. Repeat the experiment, after you have daubed over one end of the bow with the white of an egg, liquid glue, saliva, mucus, blood, a solution of tartar, or any other fluid or conducting substance sufficiently different from pure water. First, immerse the pure end, or that moistened merely with water, in the water of one of the glasses; and afterwards the other end, daubed over with the above substances, in the water of the other glass; you will then infallibly produce a convulsive movement in the frog, and several times in succession, if you draw out the bow and again immerse it until nothing more of the above substances is left adhering to the metal, or until the metal, with its ends in both the glasses, touches only pure, or nearly pure, water. Daub both the above substances uniformly over both ends of the bow, and immerse them at the same time in both the glasses of water, and no convulsions will arise. They will often be produced in newly prepared and highly irritable frogs, when the saline fluid, or, in general, the substance with which the two ends of the bow are daubed over, is not perfectly the same, or when the substance at the one end is more diluted than at the other, &c. Wash and clean carefully the one end of the bow, daub over the other more or less, and convulsions will be again produced as soon as the circle is made complete by the

the double immerfion of the bow. Clean both ends completely, and no agitation will arife, as in the firft experiment.

For comparative experiments of this kind I would recommend vifcous fluids or fubftances rather than faline, becaufe the latter are too foon diffolved in the water. It oftimes happens that the convulfions of the frog, when it is completely prepared and highly irritable, take place, though both ends of the metallic bow are daubed over with the fame kind of faline fluid. The caufe of this is, that when one end is immerfed in the water after the other, (and it may be eafily feen that it is impoffible to do fo in a moment with fufficient accuracy,) the one end of the bow lofes a portion of its faline fubftance fooner than the other, or at leaft the adhering part is more diluted by the water, fo that the fluid with which both ends have been daubed over is no longer the fame.

For thefe experiments I would alfo recommend filver, as a metal whch is lefs liable than others to be attacked and changed by faline and other liquids. Tin, lead, copper, and in particular iron, are more fufceptible of lafting variations; fo that bows of thefe metals, and of iron above all, retain for a long time the power of producing convulfions in a newly prepared and highly irritable frog, even when both the ends of the bow are immerfed in two glaffes of water, although the places of the metal, attacked by any of the faline fluids, have been carefully wafhed and cleaned. A fuperficial alteration in the metal is fufficient to produce this change, as may be eafily feen. Thefe variations often fhew themfelves to the eye by a yellow blackifh fpot, &c. which it is difficult to remove. I do not here fpeak of lafting variations, that proceed to a greater depth, which can be produced in the end of the metallic bow, and particularly in iron, when its hardnefs is changed; a procefs by which fuch a bow can be rendered capable of producing not only convulfions in frogs, but alfo a particular fenfation on the tongue, and light before the eyes, if both its ends, made perfectly clean, are only brought into contact with pure water. Thefe, and many

other experiments of the like kind, form the chief subject of my first letter to the Abbé Vassali, Professor of Natural Philosophy at Turin, written in the beginning of the year 1794, and afterwards published with the other in Brugnatelli's Journal.

If silver be less exposed to be attacked by saline and other fluids (except by liver of sulphur, which instantaneously renders it black); if it be less susceptible of considerable and lasting variations, and has therefore this advantage over other metals, that it is liable to fewer irregularities; tin, on account of its greater activity, that is, the strength of the effects which it produces by being brought into contact with almost all moist conductors, as I have already observed, is to be preferred to silver, and in a certain degree to all other metals. The experiment I have already described with a tin bason filled with an alcaline fluid, and held in the hands moistened with water, by which an acid sensation is excited on the tongue when brought into contact with the above fluid, is a proof of it; for it would be vain to expect a like effect from a bason of lead, iron, or copper, and much more so from one of silver. With the latter it would be obtained only when it contained liquid liver of sulphur; and in that case the acid taste would be pretty strong.

The electric fluid is excited also with the greatest strength and activity, when the metal is tin, between water and a saline fluid: but it will be excited with still greater energy to produce an acid sensation on the tongue when the tin is between water and an insipid mucilaginous fluid; or when the experiment is made with a tin bason filled with a solution of gum, liquid glue, white of an egg, &c. The other metals, in like circumstances, produce some effect, but much weaker: silver produces the weakest, except with liver of sulphur, as I have already observed.

A like experiment, which I made three years ago, and exhibited to various persons, not with two different fluids and one metal, as in that above described, but contrariwise,

 with

with two metals of a different kind and a fluid, is already known. I took a bafon of tin (one of zinc is better), placed it on a filver ftand, and filled it with water. When any of the perfons in company applied the tip of his tongue to the water, he found it perfectly taftelefs as long as he did not touch the filver ftand; but as foon as he laid hold of the ftand, and grafped it in his hands well moiftened, he experienced on the tongue a very perceptible and pretty ftrong acid tafte. This experiment will fucceed, though the effect is proportionably weaker, with a chain of feveral perfons who hold each other's hands, after they have been moiftened with water, while the firft applies the tip of his tongue to the water in the bafon, and the laft lays hold with his hands of the filver ftand.

If thefe experiments, in regard to the tafte excited on the tongue by the action of two different metals, are ftriking, the others, in regard to the tafte excited, modified and changed by one metal between two different fluids, are no lefs fo, and they are alfo newer. They are ftill interefting on this account, that they difcover to us the caufe of that tafte often perceived in water and other liquids, which is more or lefs confiderable or various when drunk from veffels of metal, and particularly of tin. When the outer extremity of the veffel is applied to the under lip, rendered moift by the faliva, and the tongue is extended fo as to be in contact with the water, beer, wine, &c. in the veffel, or when the tongue is bent as is done in drinking, is there not then a complete circle, and is not the metal between two more or lefs different liquids, that is, between the faliva of the under lip and the liquor in the cup or veffel? A ftronger or weaker electric ftream muft thereby be occafioned according as the fluids are different—a ftream which will not fail in its way to affect the fenfible organs of the tongue in the faid circle.

Befides the two methods already confidered, of producing an electric current, that is, by means of one or more moift conductors, or conductors of the fecond clafs, placed between two different metals or conductors of the firft clafs;

or

or contrariwiſe by means of a conductor of the firſt claſs placed between two of the ſecond claſs, alſo different; there is ſtill a third method of exciting the electric fluid, though in a degree ſo much weaker that it is ſcarcely capable of cauſing convulſions in a perfectly prepared frog, in which there is ſtill a ſtrong degree of vitality. This new method conſiſts in forming the circle of three different conductors, all of the ſecond claſs, without the intervention of one of the firſt or a metal one. Some think they find in this method a ſtrong objection againſt my principle.

Fig. 20. repreſents this third method compared with the other two*. In the experiments of Profeſſor Valli, reſpecting which ſo much noiſe has been made without any reaſon, *t* repreſents the leg of the frog, and particularly the hard tendinous part of the *Muſculus gaſtrocnemius*; *m* the rump or the muſcles of the back, or the iſchiatic nerves, to which the ſaid tendinous parts are applied; and *a* the blood, or the viſcous ſaponaceous or ſaline fluid, applied to the point of contact.

I have fully deſcribed this new method, where no metal is uſed, in my third and fourth letter to Profeſſor Vaſſali, written in the autumn and winter of the year 1795. I have there ſhewn, that theſe new facts, far from altering my ideas and principles, ſerve rather to eſtabliſh them; and that they render more general the principle that the conductors, by heterogeneous contact, that is of two different from each other, become exciters of electricity, and confirm the beautiful law ariſing from it, that to produce an electric ſtream the circle muſt neceſſarily be formed of three different conductors. You now ſee in what the whole ſecret, the whole magic conſiſts; and that it depends not merely on metals, as might have been believed, but on all the different conductors. As long as we adhere to theſe principles, it will be eaſy to explain all the before-mentioned experiments without being reduced to the neceſſity of having recourſe to any imaginary

* See Plate I. (in the preceding Number.)

principle,

principle, or any peculiar and active electricity of the organs. By their aſſiſtance you will be enabled to invent new experiments, and to foretell the reſult of them, as I have ſeveral times done, and ſtill do daily. If you, however, abandon theſe principles, you will find nothing but uncertainty and contradiction, and the whole will be an inexplicable problem.

IX. *On the Method of manufacturing Acetat of Copper, Cryſtals of Venus, or Cryſtalliſed Verdigriſe. By* J. A. CHAPTAL.*

CRYSTALS of Venus were for a long time manufactured in Holland, but at preſent they are manufactured at Montpellier, with a degree of perfection which renders them preferable to thoſe of any other country. The proceſs moſt generally employed conſiſts in diſſolving verdigriſe in vinegar, and evaporating the ſolution to a pellicle to obtain the cryſtals. The vinegar uſed is nothing elſe than ſour *vinaſſe* (ſpoilt wine) diſtilled. In every manufactory there is therefore an alembic, in which this weak kind of vinegar is continually diſtilled.

This diſtilled vinegar is put into a kettle, where it is boiled on the verdigriſe. After ſaturation the ſolution is left to clarify, and then poured into another kettle of copper, where it is evaporated to a pellicle. Sticks are then immerſed into it, and by means of ſome pack-thread are tied to wooden bars which reſt on the edge of the kettle. Theſe ſticks are about a foot long, and are ſplit croſs-wiſe nearly two inches at the end, ſo that they open into four branches, kept at about the diſtance of an inch from each other by ſmall pegs. The cryſtals adhere to theſe ſticks, and cover them entirely, forming themſelves into groups or cluſters, which preſent on all ſides perfect rhombs of a very lively dark blue colour.

* From the *Annales de Chimie*, No. 75.

Each

Each cluster weighs from five to six pounds. These crystals, when broken, exhibit on their fracture a brilliant agreeable green, inclining a little to blue.

Three pounds of moist verdigrise are necessary to make a pound of crystals. The indissolved residuum is rejected as useless. Analysis, however, having proved to me that a great deal of copper in a metallic state, or weakly oxydated, still exists in it, I disposed boards in the form of a stage around the manufactory of C. Durand, and, forming strata of about two inches in thickness with these remains, I soon saw them covered with an efflorescence of verdigrise. I took care to moisten them from time to time with vinegar, to dissolve the verdigrise as soon as a sufficiently strong efflorescence was formed, and they were again disposed in strata to proceed as before, in order that I might derive as much advantage from the residuum as I should find convenient.

There are some manufactories of the crystals of Venus where the verdigrise is prepared by means of vinegar distilled according to the method followed at Grenoble, which is well understood. All the operations tend to the same end, which is the solution of the copper in the acetous acid; and the purity of the materials renders it certain that there will be no residuum or loss. But however simple may be the process for manufacturing crystallised verdigrise, the high price at which it is sold makes it to be much wished that it could be still rendered more so. I made some experiments for that purpose; but at present I shall confine myself to a short view of my results. We must set out from the principle, that the acetous acid does not attack copper in the state of a metal, and that it cannot effect a solution of it but when reduced to an oxyd. The question then will be to discover the means of oxydating it in an economical manner.

1st, I exposed the plates of copper to the gazeous emanations of the oxygenated muriatic acid in large glass receivers, connected together in the manner of adoptors, to which I fitted a retort from which the acid was disengaged.

2d, I took

2d, I took a large earthen jar of Provence, well glazed, capable of containing two hundred (French) pints of water, buried it one half in a ſtratum of very warm dung in full decompoſition, and having put ſome mangancſe in the bottom of it, and adapted to it a ſtraight glaſs tube which reached from the mouth to the bottom, I filled the jar with plates of copper ſlightly rolled, in order that they might not touch each other but in ſome points. I then made to paſs into the bottom of the jar, by means of the tube, the neceſſary quantity of the muriatic acid, and immediately cloſed the upper aperture with a luted covering. Two days after theſe plates were entirely cruſted over with a greeniſh oxyd, which detached itſelf in duſt and in ſcales: I ſeparated of it two pounds ten ounces. This oxyd, leſs lively than that of the common verdigriſe, is ſoluble in vinegar: and this method may then be employed, with ſome advantage, to form the acetat of copper; but it cannot ſupply the place of the acetous verdigriſe either in painting or dyeing.

3d, I formed ſulphat of copper by pouring, upon plates of copper brought to a red heat in a crucible, about a third in weight of pounded ſulphur. This ſulphure, exceedingly friable, pulveriſed and expoſed to a pretty violent heat for four or five hours, left a grey powder, eaſily attacked by the acetous acid. That which I digeſted at a heat above a gentle temperature, gave, by evaporation, a conſiderable quantity of very blue and beautiful cryſtals of acetat of copper, and a ſtratum of true ſulphat of copper of a pale blue and without cryſtals.

4th, I ſaturated diſtilled acetous acid with oxygenated muriatic acid gas. This acid, digeſted cold on the copper, diſſolved it in part; but it formed a beautiful micaceous ſcaly white, which had no relation with the acetat. Copper expoſed to the vapour of this acetous acid, ſaturated with oxygenated muriatic acid gas, becomes covered with very brilliant ſmall cryſtals of a bright-blue colour, ſome of which are tranſparent and white. Theſe cryſtals preſented long

ſquare

ſquare pyramids, effloreſced in the air, and had none of the characters of the acetat of copper.

5th, The acetous acid, diſtilled ſeveral times on the oxyd of mangaueſe, attacks copper and diſſolves it, but too weakly and in too ſmall quantity for me to recommend this method.

6th, The acetite of lead poured upon a ſolution of the ſulphat of copper immediately produces a decompoſition from which there reſults ſulphat of lead, which precipitates itſelf in a little time; and acetat of copper, which remains in ſolution. By decanting the latter, and evaporating it to a pellicle in a copper kettle, you will obtain beautiful cryſtals of Venus. If you waſh well the ſulphat of lead, and prepare it to be employed in painting, as white lead, this laſt proceſs may become very advantageous.

Cryſtalliſed verdigriſe is in great requeſt for painting and varniſhing, to which it ſupplies lively and durable colours. Chemiſts obtain from it by diſtillation that acid, the ſmell of which is very penetrating, called *radical vinegar* and alſo *acetic acid.*

X. *An Attempt to determine the true Form and neceſſary Angles of Weather that ought to be given to Vanes of a Vertical Windmill as they recede from the Centre, left undetermined by Mr. Smeaton. By* RICHARD HALL GOWER, *in the Sea Service of the Honourable Eaſt India Company*.*

ON reading Mr. Smeaton's Experiments to diſcover the proper Conſtruction of Windmill Vanes, read before the Royal Society the 31ſt of May and the 14th of June 1759, I was ſorry to find that millwrights had hitherto been without any fixed principle wherewith to give the vanes of vertical windmills their proper degree of weather.

If it were required to determine by calculation the number

* Communicated by the Author.

of

of turns that would be made in a given time by a ventilator in a window, the fly of a ſmoke-jack, or the vanes of a vertical windmill, with a given velocity of wind, we muſt conſider each vane as a ſpiral curve; for ſuch a vane, when ſtruck by a reſiſting fluid, muſt of neceſſity paſs through a triangular ſpace, of which the ſpread of the extremity of the vane forms the baſe, in the time that the wind paſſes through the depth of the vane: therefore, friction and gravity being out of the queſtion, a fly of one vane will paſs round as quick as a fly with any greater number.

Some years back I made a number of experiments upon ſpiral flies moving in water, to prove what number of turns the ſpiral would *actually* make in paſſing through a certain ſpace in the direction of its axis; and I can with confidence aſſert, that (if the ſpiral be nicely made, and be ſuch as ſhall be generated by a radius moving angular, and at the ſame time perpendicular to the plane of its angular motion*) the revolutions it will make in paſſing through a certain ſpace of water in the direction of its axis, *will admit of calculation*; but that, if the flies deviate from a ſpiral, the revolutions *are not to be calculated with exactneſs*, being ever *leſs* than the perfect ſpiral will perform. Wind is a fluid in ſome reſpects ſimilar to water, particularly when applied to the preſent purpoſe; therefore, vanes which are to be turned by its power, *ought to be ſpirals, for, if not, they will ever perform leſs*.

For the purpoſe of elucidating, in the moſt clear and ſimple manner, the truth of the principle aſſerted, I cauſed a vane, or fly, to be made. This vane is repreſented by fig. 1, pl. IV. The vane moves round upon the pillar AB, which is fixed upright in a ſtand. The part of the pillar above the fly is ſquare; this carries the braſs arm CG, which may be moved up and down the pillar, parallel to itſelf, without revolving.

* This conſtruction might be otherwiſe expreſſed, thus: A ſpiral generated by the circular motion of a radius, and of a line moving at right angles, to the plane of the circular motion.

To this arm is fixed the ſtraight wires 1, 2, 3, 4, 5, 6, 7, which are intended to repreſent the wind, moving parallel, to ſtrike the vanes. To prove the truth of the principle, lift the arm up (as in fig. 1,) till the points of the wires are as high as the upper edge of the vanes, and bring the upper edge of either vane immediately under the points; then, by gently preſſing the arm down, (as ſhewn by fig. 2,) it will be obſerved that the vane is turned by *all* the points preſſing upon it *at the ſame time*, till they paſs beyond its lower edge. Now, were the vanes any other than ſpirals, this could not be the caſe; for, bring the wires to the *plane vane* AH (fig. 3), (which may be ſet to any angle), and by preſſing the arm down as before, it will be obſerved that, as the vane turns round, the points, beginning from the extremity, are quitted by the vane, which at length is acted upon by the point next the centre only: therefore it may be concluded, that the wind would not continue to act *uniformly* on any fly or vane which is not conſtructed on the principles of a ſpiral.

The ſpiral vane I, fig. 1, ends, as do the reſt, where the angle of weather (or the angle which the vane makes with the plane of its circular motion) arrives at 35°, as this admits of the extremity of the vane being ſtruck by the wind with an angle of 54°; which angle, it is demonſtrated, will produce the greateſt lateral preſſure. The ſhortening of the vanes of windmills is an object of material moment; yet I do not mean to aſſert that the angle of 35 degrees is the beſt concluding point, ſince, if more power be wanted, the length of the vanes muſt be extended. The wood, of which I formed my model, is preſerved at the back of the vanes, (ſee the dotted lines fig. 1.) merely to give a better idea of their weather as they recede from the centre. Though the number of ſpiral vanes ſhewn are ſix, yet I do not ſay that ſix are ſuperior to any other number; it being preſumed that more vanes on this principle might be placed with advantage, provided the whole area of the circle be not too much crowded, which would prevent the free eſcape of the wind.

The

The length, breadth, and angle of weather at the extremity of a vane being given; to determine the angles of weather at different diftances from the centre.

Let AB, fig. 4, be the length of the vane; BC its breadth; and BCD the angle of weather at the extremity of the vane, equal to 20 degrees. With the length of the vane AB, and breadth BC, conftruct the ifofceles triangle ABC: from the point B draw BD perpendicular to CB, then BD is the proper depth of the vane.

Divide the line AB into any number of parts (five, for inftance); at thofe divifions draw the lines 1E, 2F, 3G, and 4H, parallel to the line BC; alfo, from the points of divifion 1, 2, 3, and 4, draw the lines 1I, 2K, 3L, and 4M, perpendicular to 1E, 2F, 3G, &c. all of them equal in length to BD. Join EI, FK, GL, and HM: then the angles 1EI, 2FK, 3GL, and 4HM, are the angles of weather at thofe divifions of the vane; and if the triangles be conceived to ftand perpendicular with the plane of the paper, the angles I, K, L, M, and D, becoming the vertical angles, the hypothenufe of thefe triangles will give a perfect idea of the weathering of the vane as it recedes from the centre.

On the fuppofition that fuch a vane were infinitely extended, let us confider which part of it is moft applicable to produce power with fafety. The part of the vane next the centre, till it leffens the angle of weather to 80 or 70 degrees, fuftains but little lateral preffure; and when the weather arrives at lefs than 20 or 10 degrees, it will fuftain no more than at the centre, while, in the former cafe, the preffure tending to break the vanes is very confiderable. If we confult a figure, conftructed to fhew the lateral and direct preffure that would arife from fluids ftriking furfaces with different degrees of obliquity, I think it may be concluded, *that the part of the vane between the weather of 80 and 20 degrees, will produce the greateft effect with the leaft danger.*

XI. *On*

XI. *On the Assaying of Iron Ores and Iron Stones by Fusion. By Mr.* DAVID MUSHET *of the Clyde Iron Works. Communicated by the Author.*

AMONGST the numerous and varied attainments of human genius, the results obtained in the practice of the art of fusion are not the least to stamp the industry of man with that full approbation to which the most ardent perseverance has entitled him. Destitute of the knowledge of principle, and labouring under the most violent prejudices, the artist has in all ages marked, at lengthened intervals, the coincidence of cause with effect: upon precedent alone he has ventured to enlarge his operations, and stake his fame and fortune. To this chiefly may be attributed his partial success; and by this alone can we account for the existence of manufactures, at an early period of civilisation, in this and in other countries. Although we cannot withhold our applause from such unremitting industry, yet the deep-rooted prejudices which this implicit reverence for custom has fostered are much to be regretted. In periods remote from our time, allowance will be readily granted for persevering in a mode of practice in which others had been comparatively successful; now, however, when investigation is abroad, the foundation of these principles ought to be tried by experiment, as the only standard whereby we are enabled to ascertain truth or detect error. At this impartial tribunal, errors may be detected which corrode the vitals of our manufactories; and truths which have hitherto slept, mingled in the rubbish of unenlightened tradition, be brought to full view.

In our manufactories, the just combination of art with science is what we can seldom boast; in authors the same happy union of theory and practice is also markedly deficient; and we have constantly to regret, that the want of liberality in the individuals of the one class, and opportunity in that of the other, prevent us from feeling the happy effects of this so much desired union.

The

The process of depriving ores of their metal by fusion in the assay-furnace, and that part particularly relating to iron, which I mean to make the principal subject of this paper, lead me more immediately to make these observations. With the manufacturer, in general, the uses and propriety of the assay-furnace are seldom admitted, or, at best, are restricted to such narrow limits as to be only capable of ascertaining the quantity of iron contained in ore or iron-stone. The chemist, on the other hand, intent only upon effecting his operation, and of giving accuracy to the result, confines his observations to a certain chain of science, and seldom or never considers manufactures as the ultimate and happy end towards which his labours should be directed.

With whatever deference and respect we look up to the names of men celebrated for their indefatigable zeal and industry in the cause of science, and with whatever satisfaction we rest upon the result of their labours as to truth; yet, in general, the practical man feels dissatisfied with the manner in which those subjects are treated which come more immediately under his own observation.

It is I fear with some truth that this charge is brought against that part of the arts relative to the assaying of iron ores. We never find, in the works of those whose attention has been directed to this subject, that the least connected idea ever exists betwixt the assay and the blast-furnace, or that the agents used for reduction in the laboratory can in general be applied to works in the large way. A total silence prevails amongst authors of this class, as to the various qualities of crude iron which certain ores and certain combinations of fluxes produce: all ores, however various, are reduced to the same complex treatment, and the operation itself measured by minutes, as if the fusibility of all the widely differently-combined ores was the same.

The celebrated Bergman even, has a degree of complexity in his receipts for the assaying of iron ores, that seems un-

worthy of the fimple elements of fcience. The following one in particular feems to poffefs an air of incongruity even in the proportions, only equalled by the oddity of the affemblage of mixtures brought forward:

"100 Grains of the roafted ore, two parts of the black "flux, (equal parts of borax and nitre,) one part of tartar, "one of fal-ammoniac, one of fandever, half of (again) "borax, half of glafs, one-fourth of *clean foot*, one-fourth "of charcoal; the whole to be covered with common falt." This motley affociation of earths, alkalies, and falts, is recommended as the beft flux for ALL iron ores. The author however fhews, that the advantages which it poffeffes are not complete, from the great caution prefcribed in the mode of conveying the neceffary degree of heat; and the perfection of the operation is rendered altogether doubtful by the confequences which the overfight of a *few minutes* may occafion.

It cannot be well reconciled to our ideas of advancement in any art, that we have not yet difcovered a method of operation more perfect than that wherein a few minutes loft or gained (which error will more likely take place from the inequality of heat, than the reckoning of time,) make a variation from truth equal to 1-5th or 1-6th of the whole. The manufacturer would be in a lamentable predicament were he thus circumftanced, and obliged, by fome means or other, to take the crude iron from the blaft-furnace immediately upon being feparated from the ores, left a confiderable portion of it fhould totally difappear. If the degree of heat produced from a fmith's forge was at all times the fame, though fupplied with fuel of various natures, and under different changes of temperature, then it is moft probable that, by reckoning Bergman's time to a minute, a button of iron, accurate in its refults, might be obtained from *fome* ores by the flux he has directed to be ufed. But I cannot conceive that this fhould be an univerfal confequence: far lefs can I comprehend, after a juft feparation has been effected, that

five minutes will destroy 1-10th of the produce of metal, while the incumbent fluid protects the surface of the metallic button from the action of the atmosphere.

It is not, however, my province to enter into a minute examination of the products obtained from the use of such vitreous fluxes, which are always productive of the most oxygenated state of crude iron; and the accuracy of whose results, under a state of such high oxygenation, are always to be suspected. I have frequently proved that, in using them, the affinity of the metal was so great to oxygen, that a slight derangement of the crucible, which had thrown the vitrid fluid from any point of the surface, was immediately attended by a rapid deflagration, and a considerable portion of the iron oxydated.

I shall chiefly confine myself to a communication of those facts, which I have repeatedly confirmed, with a view of extending my results and observations to a more extensive scale. I have constantly considered the assay-furnace as capable of affording conclusions applicable to the operations of the smelting-furnace, and that change or innovation should always have the concurring testimony of truth to back them, though, on a small scale, before they be risqued on one more momentous or extensive. Influenced by such motives, I early rejected, as totally inapplicable to the scale of manufacture, the numerous tribe of salts, alkalies, and earths: these, in the application, are subject to no rule, nor guided by any immediate object of general utility, but are as arbitrary as their authors are numerous. On the contrary, I have directed my endeavours to the use of such agents as effect separation upon the large scale, and have been fortunate to find that the same solvents, when properly applied, are productive of the most perfect and finished results. By the simple application of lime or chalk, in various proportions, as a calcareous earth, and common bottle glass, in the place of silex, to constitute fusibility, I have been able to produce in the assay-furnace all the various qualities of crude

 iron,

iron, as to ſtrength and fuſibility. In no caſe has the reſult of any aſſay been conſidered perfect, unleſs the vitrid maſs found upon the ſurface of the metallic button exhibited a degree of tranſparency and purity of colour little inferior to flint glaſs, or ſlightly darkened by a faint ſhade of azure. In ſuch vitrifications, purity of colour is the ſureſt proof of the non-exiſtence of iron in the ſtate of a fuſed oxyd: the ſame degree of pellucidity renders it eaſy to detect the ſmalleſt globule of metal which by chance may have been ſuſpended during fuſion. In all experiments where a juſt aſſociation of mixtures has been preſent to produce this peculiar ſcoria, the quality of the iron will be found richly carbonated, and the button poſſeſſing a ſmooth, ſilvery, greaſy-feel ſurface. On the other hand, experience has repeatedly ſhewn, that when the ſcoria obtained in aſſaying approached not to the colour and purity of fine glaſs, there remained a portion of the iron ſtill unrevived, in the ſtate of a fuſed oxyde, conveying colour and opacity to the maſs; that at certain degrees of colour, certain degrees of opacity exiſted, and proportionate quantities of the metal remained diffuſed in the ſcoria. When the colour of this was green, the quantity of metal united was ſmall; but as the green deepened, and became aſſociated with light browns, the quantity of unrevived iron was greater, and became much increaſed as the ſcoria aſſumed darker browns, or became totally black: in ſuch inſtances I have found it contain, upon being re-aſſayed, 12 *per cent*. The aſſaying of iron ores is ſuſceptible of another extreme, by which experiment is equally clogged, and wherein it is very difficult to obtain an accurate reſult. In this caſe no perfect button of metal is found, but the portion of iron which the ore contained is in a vaſt variety of various ſized globules of the richeſt crude iron, interſperſed in, or covering the ſurface of a ſemi-vitrified opaque maſs of ſcoria, of a greyiſh-blue, mottled, or whitiſh colour. The cauſes of which, and their ſtrict analogy to ſimilar reſults in the blaſt-furnace, ſhall be my chief object to explain.

In

In a former paper I mentioned, that if iron-ſtones were ſmelted without the addition of any other ſubſtance, the product in iron would be proportioned to the quantity of lime contained in the reſpective claſſes. We ſhall ſee from the following experiments how far this is confirmed by means of the aſſay-furnace, and furniſh to ourſelves one important leſſon, How far the various mixtures of ores affect the operation of ſmelting?

1ſt, Into a crucible, with a well-fitted cover, I introduced 875 grains of a pulveriſed ſiliceous iron-ſtone in its raw ſtate, and applied ſuch degree of heat as is uſually given in ſuch operations. In twelve minutes I found that the iron-ſtone was in perfect fuſion, much agitated, and emitting large bubbles of ignited gas of a fiery colour. In forty minutes the crucible was withdrawn; the ſurface of the vitrid fluid ſtill continued to boil, and emit bubbles, though in leſs quantity. In this ſtate I introduced a ſmall rod through the ſcoria, and diſcovered the ſurface of a button of metal. The moment it came into contact with atmoſpheric air, a beautiful combuſtion took place; the metal roſe in a ſpiral form to ſupply the rapid inflammation, and continued till the ſcoria (ſtill in fuſion) cloſed over the ſurface of the button. When cold, I found a perfect formed button of extremely oxygenated crude iron, which weighed 219 grains; a produce equal to 25.1 *per cent.* from the raw iron-ſtone. The ſcoria obtained was of a ſhining black colour, firm and ponderous, and weighed 402 grains; ſo that the loſs in volatile matter was 254 grains, equal to 29 *per cent.*

Although this iron-ſtone was ſiliceous, yet I am convinced the loſs of volatile matter would have been greater, had not nearly one-half of the whole contents of iron remained in the ſcoria, united with oxygen, at the rate of 35 *per cent.* I found the produce of the metallic button thus obtained white as ſilver, and preſenting imperfect radii; the ſurface was conſiderably oxydated, eſpecially where the combuſtion had taken effect.

2d, I fubjected to a fimilar treatment 875 grains of an argillaceous iron-ftone, which contained a ufual proportion of lime; the fufion of this powder was more difficult than that of the former, though the phenomena exhibited by both during reduction were alike. The crucible was withdrawn from the furnace in forty minutes after introduction, and the furface of the button expofed to combuftion as before. The deflagration differed little in point of appearance from that effected with the filiceous iron-ftone: the button of crude iron was found oxygenated, and weighed 249 grains; a produce in iron from the raw ftone = 28.5 *per cent.*: the vitrid mafs was found to weigh 354 grains; the lofs of volatile mixtures was therefore 272 grains, or 31 *per cent.* The fracture of the regulus now obtained was ftill white, though not allied to any degree of cryftallifation, and its furface fmoother and lefs oxydated. The glafs produced in this experiment was of a deep brown fhining colour, in many places porous, and enriched with fine tints of colouring.

3d, The fame experiment was repeated upon 875 grains of a fine calcareous iron-ftone. The fufion of this required a violent heat of feventeen minutes, during which time the difengagement of a gafeous fubftance was moft evident; in other refpects it exhibited the fame features, when in fufion, as the two former: the degree and length of heat conveyed was nearly the fame; and the refult obtained was a button of carbo-oxygenated crude iron * weighing 261 grains; a produce

* Although in this experiment a true carbonation is effected by means of the prefence of lime alone, yet experience has never confirmed this in the large way; nor fhewn, after a juft proportion of materials was in the furnace, that additional lime alone conferred any additional degree of carbonation. The widely different manner in which the heat is excited, and the fubftances which are operated upon expofed to its action, may account for this want of coincidence of effect. It is the fame principle that C. Clouet has lately ingenioufly applied to the fabrication of caft fteel from bar iron. To the decompofition of the carbonic acid alone, I attribute the advantages derived from the ufe of lime in the manufacturing of crude iron,

produce in iron equal to 30 *per cent.* from the raw iron-ſtone; fuſed earths, now reduced to an opaque brown glaſs ſtreaked with white, 294 grains: loſs in volatile mixtures 320 grains, or 36.5 *per cent.*

The metallic button produced in this operation had a ſmooth cryſtalliſed ſurface; and, when in fuſion, combined leſs readily with oxygen offered by the contact of atmoſpheric air, than did the former two. The fracture was light grey, with a regular diſtinct grain; the maſs of fuſed earths were diſpoſed after the manner of a cryſtalliſation, in radii, ſhooting from the circumference of a minute circle to the extremity of one larger.

From theſe experiments it is obvious that reguli of crude iron may be obtained from the different claſſes of iron-ſtones, of a reſpectable produce, without any addition whatever; and that the tendency which theſe have to part with their iron is in the exact ratio of the quantity of lime preſent. The following ſtatement exhibits the difference betwixt the real and partial aſſay of the foregoing iron-ſtones.

The ſiliceous iron-ſtone, properly aſſayed, yielded 34.5 *per cent.*, but by fuſion *per ſe* only 25; leaving in the latter method 9.5 mixed with the ſcoria. Argillaceous ſtone, properly aſſayed, gave 35.6, by fuſion *per ſe* 28.5; leaving 7.1 mixed with the ſcoria. Calcareous iron-ſtone, properly aſſayed, yielded 33.7, by fuſion *per ſe* 30; which left 3.7 mixed with the ſcoria.

One reaſon may be advanced why the iron produced from the calcareous ſtone was ſo much more in proportion than the other two claſſes: both the ſiliceous and argillaceous buttons, when deprived of their ſcoria, decompoſed atmoſpheric air ſo rapidly as to ſuffer a little, in point of real metal, from the combination of oxygen. It was otherwiſe, however, when the ſurface of the calcareous button was expoſed: the affinity of the oxygen to the metal being leſs

iron. I have for the laſt three years made uſe of this truth with the greateſt advantage in the aſſaying of ores and other experiments.

than

than to the carbon united with it, carbonic acid was formed. A review of these experiments leads to another conclusion, that, without the presence of carbon, either in chemical union in the ore, or attracted from the ignited gas by the particles of metal, crude iron will not separate from the ore or stone; and that, in proportion as the metal is exposed to inhale this principle, its produce is increased and its quality improved.

It will further appear obvious, from the various natures of scoriæ which the different iron-stones afford when fused *per se*, that there exists a want of mixture in most of them to form, when fused, a fluid so sufficiently divided that no portion of iron may be retained, either in a metallic state, or in that of an oxyde. This deficiency of mixture is greatest in the siliceous iron-stones, less in the argillaceous, and least of all in the calcareous. The principle, therefore, I proceeded upon was, to ascertain what proportion of additional mixture, and of what nature, was necessary to give the proper equilibrium to form a transparent scoria. When silex predominated, it was found that a major proportion of calcareous earth, in the solvent or flux, supplied the natural deficiency; and that the whole contents in iron were justly revived, and fully saturated with carbon: when at any time it was wished to revive the metal, contained in such ores, possessing strength with carbonation, I found that this could be easily effected, in all proportions, by the addition of calcareous earth with a mixture of pure clay. In short, in every experiment I have made with ores, the various natures of lime-stones, or chalk, with certain proportions of bottle glass, have been found capable of reviving the iron contained in all the ores which have come under my knowledge, and of conferring upon their respective products every degree of strength and fusibility *. In order to form an accurate judgment of the tendency

* Although I have frequently had occasion to mention the combination of clay with iron-stone, as the mixture which in fusion conveyed strength

dency which individual ores have to afford their metal carbonated, poſſeſſing ſtrength, or otherwiſe, a flux of a medium proportion of calcareous earth and glaſs is determined upon; ſuch as, with an iron-ſtone of that genus, would afford ſuper-carbonated crude iron. Let the button of iron ſo obtained be the ſtandard whereby to judge of ſucceeding reſults; and let all the ores belonging to the ſame mine, or uſed at the ſame work, be compared with it: theſe will be found, according to their mixtures, poſſeſſing different degrees of carbonation; ſome of them white in the fracture, and others again as richly carbonated as the ſtandard regulus; their degrees of ſtrength alſo approaching or receding from the ſtandard as they approximate or vary from the nature and proportion of its original mixture.

To complete ſuch an undertaking with accuracy, requires a minute knowledge of the operations of the aſſay-furnace, and the degree of heat from time to time excited: the quantity of ore in ſuch a chain of experiments ſhould be at all times the ſame, and the requiſite heat conveyed and completed at ſimilar ſtages of fuſion and of ſeparation. Strict

ſtrength to the metal, yet I have not ventured a conjecture how far and in what manner the mechanical ſtructure of the metal is altered when additional ſtrength is thus obtained. It will be a difficult matter to decide, whether it is derived from the natural infuſibility of the clay, by preventing ſeparation for a longer time, and new modifying the ſtructure of the particles of metal; or whether the acquired ſtrength is entirely owing to the moleculæ of the metal becoming more flattened and tenacious by a varied ſtage of cryſtalliſation. Moſt probably it is owing to both cauſes, and that the former is productive of the latter; the one the cauſe, and the other the effect accounted for.

We find, that from ſiliceous iron-ſtone, which is fuſed with the greateſt facility, iron is obtained uncommonly white and brittle; and again, from pure calcareous iron-ſtones, which are ſtill more difficult to reduce than the other two claſſes, we find an oppoſite extreme of brittleneſs, ariſing from an extra combination of carbon, which deſtroys the continuity of the particles to each other. Clay ſtill holds the medium; and its addition alone reſtores a juſt equilibrium, not of ſtrength only, but of fuſibility.

accuracy of refult, as to the quantity of metal, will not always be obtained; but a very comprehenfive knowledge will be formed of the nature of the earthy mixtures, and the ftrength and fufibility of the metal. Once in the poffeffion of thefe, it will be no difficult matter to fuperadd a portion of earths requifite for perfect reduction. In two fimple experiments, therefore, not only the real quantity of metal contained in the ore is obtained, but its prefumptive ftrength and fufibility developed in a great meafure prior to its application to the purpofes of the blaft-furnace.

In order to facilitate this operation, and to compare the various degrees of heat in which different experiments are effected, I conftructed a pyrometer upon the principle of the expanfion of metal by heat: a reprefentation of which, and a defcription of its ufe, will form an article for the next Number of the Philofophical Magazine.

XII. *Agenda, or a Collection of Obfervations and Refearches the Refults of which may ferve as the Foundation for a Theory of the Earth. By* M. De Saussure.

[Continued from page 71.]

CHAP. XVII.

Obfervations to be made on the Remains and Veftiges of organized Bodies found in the Earth, in Mountains, and at their Surface.

1. THEIR nature, bulk, and quantity; the extent, depth, and other dimenfions of the ftrata where they are found *.

2. Their prefervation. Whether entire or broken, decompofed or not; fhells with their pearly covering (*nacre*); their colour; remains or traces of their fifh, or their fkin if there be any. To deduce, if poffible, from thefe data, fome idea

* 1. A. If formed of trees, to mark down the direction of the ftrata; and whether they are placed horizontally, or inclined either towards the fummit or the roots. C.

of

of the time that has elapfed fince thefe organifed beings were depofited in the bofom or at the furface of the earth.

3. The nature of the objects by which they are accompanied; fuch as fand, gravel, flints: whether angular or round; whether there are found in their neighbourhood other veftiges of organifed bodies *.

4. Their nature. Whether they are lying in their natural pofition, or reverfed, and turned upfide down, fo as to afford reafon to conclude that they died on the fpots which they now occupy; or whether they have been tranfported thither by fome violent and irregular movement: whether, for example, the fhells have the fame attitude as in the bofom of the fea, the univalves on their mouth, and the bivalves on the valve that is leaft convex.

5. Whether they are in families, as in ftagnant waters; or, on the contrary, thrown together in an irregular manner.

6. Whether all thefe circumftances are the fame throughout the whole extent of the fame bank; in the contiguous banks of the fame lands, and the fame mountains, and in thofe of the neighbourhood.

7. To afcertain whether foffil fhells are found in the moft ancient mountains, and not in thofe of a more recent formation; and thus to clafs, if poffible, the relative ages and epochs of the apparition of the different fpecies.

8. To compare exactly the bones, fhells, and foffil plants with the living plants analogous to them; and thus to afcertain the truth of the affertion of Michaelis, that the foffil bones of quadrupeds (fuch as the elephant, rhinoceros, oxen, and ftags,) have not an exact refemblance to thofe which are found at prefent alive.

9. If they are really different, to determine whether thefe differences are not varieties, or whether they characterife fpecies.

10. Whether, on the other hand, their identity is con-

* To pay particular attention to thofe of fuch organifed bodies as may be found in the real veins. C.

firmed

firmed with thoſe of analogous living ones; viz. to aſcertain whether theſe analogous living ones are found at preſent, or have been found within the memory of man, in thoſe countries which contain remains of them; and if the anſwer is negative, to diſcover the ſituation and diſtance of the neareſt country where they are found.

11. If no analogous ones exiſt alive at preſent but in climates where the temperature is very different, to aſcertain whether there are any indications of their having formerly exiſted, and of their having been conveyed to thoſe countries where remains of them are ſtill found; or whether, on the contrary, theſe remains ſeem to have been tranſported thither by currents, tides, or any other great movement of the waters.

12. In the like manner, whether there are found in the cold countries veſtiges of the productions of warm countries; or reciprocally, whether in warm countries there are found veſtiges of the productions of cold countries.

13. Whether foſſil wood, or other veſtiges of organiſed bodies, are ſituated in ſuch a manner as to indicate that there were in the ancient ocean iſlands abounding with animals and vegetables.

14. To ſtudy with care the immenſe accumulations of bones depoſited in heaps (*nids*), or ſtrata, in the iſles of Cherſo, Oſero, and elſewhere.

15. To examine the nature of the caverns which contain them; ſuch as *Baumannſhœlé*, and others*.

16. Whether it appears that theſe caverns were the voluntary retreats of thoſe animals who died there a natural death, or whether their bodies were conveyed thither by the waters †.

[To be continued.]

* In the Harz, and thoſe of Gailenreuth in Franconia. C.

† Or, whether theſe bones are found, not only in caverns, but alſo in the ſtrata from which the caverns have been formed. C.

XIII. *On the Cure of Perſons bitten by Snakes in India**. *By* JOHN WILLIAMS, *Eſq.*

THE following ſtatement of facts relative to the cure of perſons bitten by ſnakes, ſelected from a number of caſes which have come within my own knowledge, require no prefatory introduction, as it points out the means of obtaining the greateſt ſelf-gratification the human mind is capable of experiencing, That of the preſervation of the life of a fellow-creature, and ſnatching him from the jaws of death, by a method which every perſon is capable of availing himſelf of. Eau de Luce, I learn from many communications which I have received from different parts of the country, anſwers as well as the pure cauſtic alkali ſpirit; and though, from its having ſome eſſential oils in its compoſition, it may not be ſo powerful, yet, as it muſt be given with water, it only requires to increaſe the doſe in proportion; and, ſo long as it retains its milky white colour, it is ſufficiently efficacious.

From the effect of a ligature applied between the part bitten and the heart, it is evident that the poiſon diffuſes itſelf over the body by the returning venous blood; deſtroying the irritability, and rendering the ſyſtem paralytic. It is therefore probable that the volatile cauſtic alkali, in reſiſting the diſeaſe of the poiſon, does not act ſo much as a ſpecific in deſtroying its quality, as by counteracting the effect on the ſyſtem, by ſtimulating the fibres, and preſerving that irritability which it tends to deſtroy.

CASE I. In the month of Auguſt 1780, a ſervant of mine was bitten in the heel, as he ſuppoſed, by a ſnake; and in a few minutes was in great agony, with convulſions about the throat and jaws, and continual grinding of the teeth. Having a wiſh to try the effects of volatile alkali in ſuch caſes, I gave him about forty drops of Eau de Luce in water, and applied ſome of it to the part bitten. The doſe was re-

* From the *Aſiatic Reſearches.*

peated every eight or ten minutes, till a fmall phialful was expended: it was near two hours before it could be faid he was out of danger. A numbnefs and pricking fenfation was perceived extending itfelf up to the knee, where a ligature was applied fo tight as to ftop the returning venous blood, which feemingly checked the progrefs of the deleterious poifon. The foot and leg, up to where the ligature was made, were ftiff and painful for feveral days, and, which appeared very fingular, were covered with a branny fcale.

The above was the firft cafe in which I tried the effects of the volatile alkali, and, apprehending that the effential oils in the compofition of Eau de Luce, though made of the ftrong cauftic volatile fpirit, would confiderably diminifh its powers, I was induced, the next opportunity that offered, to try the effects of pure volatile cauftic alkali fpirit, and accordingly prepared fome from quicklime and the fal ammoniac of this country.

II. In July 1782, a woman of the Brahmen caft, who lived in my neighbourhood at Chunar, was bitten by a Cobra de Capello between the thumb and fore-finger of her right hand. Prayers and fuperftitious incantations were practifed by the Brahmens about her, till fhe became fpeechlefs and convulfed, with locked jaws, and a profufe difcharge of faliva running from her mouth. On being informed of the accident, I immediately fent a fervant with a bottle of the volatile cauftic alkali fpirit, of which he poured about a tea-fpoonful, mixed with water, down her throat, and applied fome of it to the part bitten. The dofe was repeated a few minutes after, when fhe was evidently better, and in about half an hour was perfectly recovered.

This accident happened in a fmall hut, where I faw the fnake, which was a middle-fized Cobra de Capello. The Brahmens would not allow it to be killed. In the above cafe, no other means whatever were ufed for the recovery of the patient than are here recited.

III. A woman-fervant in the family of a gentleman at Benares,

Benares, was bitten in the foot by a Cobra de Capello. The gentleman immediately applied to me for ſome of the volatile cauſtic alkali, which I fortunately had by me. I gave her about ſixty drops in water, and alſo applied ſome of it to the part bitten. In about ſeven or eight minutes after, ſhe was perfectly recovered. In the above caſe I was not witneſs to the deleterious effect of the poiſon on the patient; but ſaw the ſnake after it was killed.

IV. In July 1784 the wife of a ſervant of mine was bitten by a Cobra de Capello on the outſide of the little toe of her right foot. In a few minutes ſhe became convulſed, particularly about the jaws and throat, with a continued gnaſhing of the teeth. She at firſt complained of a numbneſs extending from the wound upwards; but no ligature was applied to the limb. About ſixty drops of the volatile cauſtic ſpirit were given to her in water, by forcing open her mouth, which was ſtrongly convulſed: in about ſeven minutes the doſe was repeated, when the convulſions left her; and in three more ſhe became ſenſible, and ſpoke to thoſe who attended her. A few drops of the ſpirit had alſo been applied to the wound. The ſnake was killed and brought to me, which proved to be a Cobra de Capello.

V. As it is generally believed that the venom of ſnakes is more malignant during hot dry weather than at any other ſeaſon, the following caſe, which occurred in the month of July 1788, when the weather was extremely hot, no rain excepting a ſlight ſhower having fallen for many months, may not be unworthy of notice:—

A ſervant belonging to an officer at Juanpoor, was bitten by a ſnake on the leg, about two inches above the outer ancle. As the accident happened in the evening, he could not ſee what ſpecies of ſnake it was. He immediately tied a ligature above the part bitten; but was in a few minutes in ſuch exquiſite torture from pain, which extended up his body and to his head, that he ſoon became dizzy and ſenſeleſs. On being informed of the accident, I ſent my ſervant

with a phial of the volatile cauſtic alkali, who found him, when he arrived, quite torpid, with the ſaliva running out of his mouth, and his jaws ſo faſt locked as to render it neceſſary to uſe an inſtrument to open them and adminiſter the medicine. About forty drops of the volatile cauſtic ſpirit were given to him in water, and applied to the wound; and the ſame doſe repeated a few minutes after. In about half an hour he was perfectly recovered. On examining the part bitten, I could diſcover the marks of three fangs; two on one ſide, and one on the other; and, from the diſtance they were aſunder, I ſhould judge it a large ſnake. More than ten minutes did not appear to have elapſed from the time of his being bitten till the medicine was adminiſtered. The wounds healed immediately, and he was able to attend to his duty the next day. Though the ſpecies of ſnake was not aſcertained, yet I judge, from the flow of ſaliva from the mouth, convulſive ſpaſms of the jaws and throat, as well as from the marks of three fangs, that it muſt have been a Cobra de Capello; and though I have met with five and ſix fangs of different ſizes in ſnakes of that ſpecies, I never obſerved the marks of more than two having been applied in biting in any other caſe which came within my knowledge.

VI. In September 1786 a ſervant belonging to Captain S——, who was then at Benares, was bitten in the leg by a large Cobra de Capello. He ſaw the ſnake coming towards him, with his neck ſpread out in a very tremendous manner, and endeavoured to avoid him; but, before he could get out of his way, the ſnake ſeized him by the leg, and ſecured his hold for ſome time, as if he had not been able to extricate his teeth. Application was immediately made to his maſter for a remedy, who ſent to conſult me; but, before I arrived, had given him a quantity of ſweet oil, which he drank. So ſoon as I ſaw him, I directed the uſual doſe of volatile cauſtic alkali to be given, which fortunately brought away the oil from his ſtomach, or it is probable that

that the ſtimulating effect of the volatile ſpirit would have been ſo much blunted by it, as to have become inefficacious: a ſecond doſe was immediately adminiſtered, and ſome time after, a third. The man recovered in the courſe of a few hours. As oil is frequently adminiſtered as a remedy in the bite of ſnakes, I think it neceſſary to caution againſt the uſe of it with the volatile alkali, as it blunts the ſtimulating quality of the ſpirit, and renders it uſeleſs.

Of the numerous ſpecies of ſnakes which I have met with, not above ſix were provided with poiſonous fangs; though I have examined many which have been conſidered by the natives as dangerous, without being able to diſcover any thing noxious in them.

The following is an inſtance of the deleterious effect of the bite of a ſnake, called by the natives Krait, a ſpecies of the Boa, which I have frequently met with in this part of the country:—

VII. On the 16th September 1788 a man was brought to me who had been bitten by a ſnake, with the marks of two fangs on two of his toes; he was ſaid to have been bitten above an hour before I ſaw him: he was perfectly ſenſible, but complained of great pain in the parts bitten, with an unuſual languor. I immediately gave him thirty drops of the volatile cauſtic alkali ſpirit in water, and applied ſome of it to the wounds. In a few minutes he became eaſier, and in about half an hour was carried away by his friends, with perfect confidence in his recovery, without having taken a ſecond doſe of the medicine, which indeed did not appear to have been neceſſary: but whether from the effect of the bite of the ſnake, or the motion of the dooly on which he was carried, I know not; but he became ſick at the ſtomach, threw up the medicine, and died in about a quarter of an hour after. The man ſaid that the ſnake came up to him while he was ſitting on the ground; and that he put him away with his hand once, but that he turned about and bit him, as deſcribed. The ſnake was brought to me, which

I examined: it was about two feet and a half long, of a lightiſh-brown colour on the back, a white belly, and annulated from end to end with 208 abdominal and 46 tail ſcuta. I have met with ſeveral of them from thirteen inches to near three feet in length: it had two poiſonous fangs in the upper jaw, which lay naked, with their points without the upper lip. It does not ſpread its neck, like the Cobra de Capello, when enraged; but is very active and quick in its motion.

I have ſeen inſtances of perſons bitten by ſnakes, who have been ſo long without aſſiſtance that, when they have been brought to me, they have not been able to ſwallow, from convulſions of the throat and fauces, which is, I obſerve, a conſtant ſymptom of the bite of the Cobra de Capello: and indeed I have had many perſons brought to me who had been dead ſome time; but never knew an inſtance of the volatile cauſtic alkali failing in its effect, where the patient has been able to ſwallow it.

XIV. *On the Metallic Particles contained in the Aſhes of Vegetables.* *By* M. De la Metherie *.

FROM obſervations which have been made, there is no reaſon to doubt that Nature never produces any thing new on the one hand, without decompoſing ſomething old on the other. The proceſs of boiling ſaltpetre, explained by the remarks of naturaliſts, has ſhewn that earth, freed from all ſalts by lixiviation, as ſoon as it is heaped up againſt new walls expoſed to the open air, becomes again impregnated with different new ſalts: but theſe, however, have been formed by the experiments of Lavoiſier, Thouvenel, and myſelf, through the effects of various artificial kinds of air. The greater part of ſalts are produced in the ſame manner in organiſed bodies; and thus plants produce vitriolated tartar, ſulphur, nitre, both the fixed alkalies, and perhaps alſo

* From the *Journal de Phyſique*, Vol. XXIII.

volatile

volatile alkali. The animal fluids give fever falts, (carbonat of ammonia,) fal-ammoniac, nitre, &c. Oils both fweet and effential, flimy bodies, and extracts belong exclufively to the works of animated Nature. Even the different kinds of gafes combined with each other produce new kinds, as may be feen in plants, which convert foul air into oxygenated. Ought not the other fubftances found in organifed bodies to be afcribed to the like works of Nature?

Becher and Henkel firft fhewed that all vegetables contain iron and gold, and fince their time this fact has been placed beyond any doubt. Many chemifts, particularly Lauragais, Rouelle, Darcet, Sage, Berthollet, &c. obtained both thefe metals from plants by reducing them to afhes *. Are thefe fubftances contained in thofe things which furnifh nourifhment to plants, or are they produced by vegetation? This queftion can be applied alfo to the earth contained in plants. Duck-weed and all plants of this kind grow in the pureft water, and we daily fee bulbous plants fhooting up in it.

Van Helmont relates, that he planted a fhoot of woad, weighing fifty pounds, in a hundred pounds of earth. He watered it with diftilled water, and in five years it weighed 169 pounds 3 ounces: the earth had loft of its weight only two ounces. Bonnet and Duhamel reared plants in the pureft water, and they grew as well as in the beft foil. It may be afked, then, if particles fufceptible of being attracted by the magnet could have been found in the afhes of thefe plants, as well as in thofe of plants that grew in fields or gardens?

The author repeated many of thefe experiments. He calcined a part of various feeds, and extracted the ferruginous particles from them by means of a magnet; the other part he fuffered to fhoot, and to grow up in diftilled water.

* Since the time of their experiments manganefe has been found diffufed through plants, next in quantity to iron. See Scheele's Effays. Edit.

 Their

Their aſhes gave a much greater quantity of metallic particles than the ſeeds, and produced alſo much more earth.

As Nature produces, in plants, ſalts, oil, and ſlime, may ſhe not, in like manner, produce earth, iron, and gold in a metallic form? and, in this proceſs, may ſhe not employ water, light, and different kinds of gaſes, which it appears contribute moſt to the formation of ſalts and oils? In this manner metals would be brought very near to ſaline ſubſtances, which ſeveral chemiſts have already ſuſpected.

XV. *Obſervations on Native Iron found in Strawberries*.*

IT appears from the preceding article to be a circumſtance well known to naturaliſts, that in the aſhes of plants there are a great many particles ſuſceptible of being attracted by the magnet, and which conſequently muſt be of the nature of iron; but that this metal has been found in plants under its original metallic form, is a fact known only to a few. Grains of gold, however, according to the aſſertion of Becher, have at times been found in grapes, and threads of gold have been diſcovered in the roots of corn; tin and lead in the interior parts of plants; quickſilver in wood, &c.: but it has never perhaps been thought poſſible that iron ſhould be found amidſt the corroding juices of a plant, becauſe no metal is ſo eaſily decompoſed as iron, merely by the moiſture of the atmoſphere, acids, and the like.

A certain anonymous friend of natural hiſtory dined with ſeveral gueſts in the month of June 1781, at the houſe of his ſiſter, ſituated on the road to Peterſhof, not far from Peterſburgh: after dinner ſome ſtrawberries were placed on the table, in a plate, as part of the deſſert along with other kinds of fruit. The anonymous perſon ate of the ſtrawberries, as did all the other gueſts, without perceiving any thing

* From the *Journal de Phyſique*, Nov. 1783.

remarkable; but one of the company at laſt called his attention to ſome hard black grains which he found in the berries he had eaten, and he ſoon obſerved that grains of the like kind were contained in thoſe which he was eating himſelf. He did not imagine that theſe grains were iron, but he however wrapped them up in a bit of paper and carried them home with him, in order that he might examine them with more attention. He accordingly tried them by a magnet, and having obſerved that they were attracted by it, he entertained no doubt that they were real native iron. It deſerves to be remarked, that the perſon to whom the anonymous naturaliſt was indebted for this diſcovery, and whoſe veracity is free from the leaſt ſuſpicion, aſſerted that he had often before found like particles of iron in the ſtrawberries which he ate on the ſame farm. Theſe particles were of various forms and ſizes, but more or leſs flatted. Their black colour was very ſimilar to that of ore found in dirty iron mines, only that it was much paler.

On cloſer examination, by means of a magnifying glaſs, theſe bodies appeared to be fragments broken off from larger pieces of iron, ſo that, with a little aſſiſtance from the imagination, traces of a regular fracture might be perceived on them. But even, whether we ſuppoſe that they were conveyed into the fruit as bodies before in a ſtate of exiſtence, or were gradually formed in the interior part of them, the explanation of the phenomenon will ſtill be attended with difficulty. Their flatted form ſeems to oppoſe the idea of their having been produced in the fruit; but on the other hand, that of their being conveyed into the fruit with the juices through the ſtem, appears to be attended with much greater difficulty. The moſt ſingular circumſtance is, that ſo many of theſe fruit in that diſtrict ſhould have been furniſhed with theſe ſmall bodies, and that they ſhould have been found exactly in the centre.

Another inſtance of native iron being found, mentioned by the ſame anonymous author, is perhaps leſs ſtriking, but

yet worthy of attention. In the neighbourhood of the town of Baturin in the Ukraine, there are a number of pleaſant little hills interſected by various ravines formed by the waters. In theſe ravines there are found in different places white globular maſſes of calcareous ſtone, which on the outſide bear marks as if they had been rubbed againſt black ſtones; theſe marks do not go deeper than the ſurface, and appear to be the work of ſome mineral pigment. The ſize of theſe maſſes approaches near to that of a walnut: it is however difficult to break them; and the nearer you get to the nucleus, which is diſtinguiſhed from the external covering by a green yellowiſh colour, the finer and harder the grain is found. The middle of this ſtone conſiſts of ſeveral cells ſeparated from each other by partitions, ſome of which are exceedingly thin. Theſe ſtone maſſes may be conſidered either as excreſcences or petrefactions, and may be claſſed among the carpolites or alcyonites; but this is of little conſequence.

What, however, deſerves attention is, that, in one ſpecimen which was broken, there were found in two of the cells two ſmall grains which were immediately known to be iron by their being attracted by a magnet. The ſmaller fell from the hands of the obſerver, and was loſt almoſt as ſoon as it had been diſcovered; but the other, which is ſtill in his poſſeſſion, has the exact ſhape of the cavity in which it lay, and is not much bigger than the head of a large pin. Theſe diſcoveries afford a new proof that the exiſtence of native iron is neither ſo uncommon nor ſo problematical as mankind in general believe.

XVI. *Seventh*

XVI. *Seventh Communication* from Dr.* THORNTON, *Physician to the General Dispensary, &c. &c. relative to Pneumatic Medicine.*

A REMARKABLE CASE OF PUTRID FEVER CURED BY THE INHALATION OF VITAL AIR.

AFTER attending a family labouring under putrid fever, I was seized myself with the same fever, but it was prevented forming by an emetic and calomel cathartic. It assailed next my wife, who being advanced in pregnancy, the same remedies could not be applied, and the fever actually formed itself. The symptoms became so alarming, that mustard cataplasms were applied to the feet; and there arising, towards the close of the disease, violent startings of the tendons, and a cold clammy sweat, with a fluttering and sunk pulse, I was induced to make trial of the oxygen air nearly in a pure state, and Mrs. Thornton was immediately revived by this remedy, and, after a fever which lasted one and twenty days, recovered. A servant in the house, and a nurse, were next seized; and I had the maid taken out of bed, and made her inhale thirty quarts of vital air, mixed with twice that quantity of atmospheric; which being repeated for a few days, she was completely restored. The nurse had an emetic, and went home. My two children were afterwards seized with the same fever; and being declared by the gentleman who attended them past all hopes, I ordered a carriage to be procured, and took them immediately to the top of Highgate Hill, where they were composed to sleep by the keen country air, and came home greatly revived; which excursion being repeated daily, they both recovered, to the surprise of every one. Seeing the good effects of air, and of factitious oxygen air, I adopted both in the fullest manner in the instance about to be recorded, the result of which the reader will see from the following

* These are all *original* Communications, never having been before published. EDITOR.

letter

letter from Mr. Corpe, an eminent ſurgeon and apothecary upwards of thirty years:—

To Dr. Thornton.

Barnet, June 11, 1799.

DEAR SIR,

My daughter was taken, the 27th of February 1798, with chills, followed by ſhiverings, conſiderable loſs of ſtrength, and depreſſion of ſpirits. She continued ſuffering much from chills for about four or five hours, after which ſhe complained of heat and fluſhing in her face, not attended with much thirſt, and was a little delirious that night. The next day the ſymptoms increaſed, and the debility was ſo great that I was obliged, after the firſt paſſages had been thoroughly cleanſed, to have recourſe to wine and bottled porter, together with cordial antiſeptic medicines; which plan was purſued, under your direction, during the progreſs of the diſeaſe; towards the cloſe of which, the poor child was ſo ſhockingly debilitated, that we expected every minute would be her laſt, which induced you to direct vital air*, by which, and the conſtant uſe of ſtrong vinegar, thoroughly ſprayed with a hearth-bruſh all over the room and curtains of the bed, revived her aſtoniſhingly: but the manner in which ſhe conſtantly revived, after inhaling the vital air, muſt be chiefly attributed to it, as the vinegar had been uſed in the way before mentioned almoſt from the very beginning of the diſeaſe, and was, I believe, not only of great uſe to the patient, but prevented the fever ſpreading in my family. No poor human being, I believe, ever had a narrower eſcape from death; and I ſhall always feel myſelf under the higheſt obligations poſſible to you for your attention and extraordinary ſkill in reſtoring my dear child, with God's aſſiſtance, to, Dear Sir,

Your much obliged and faithful Servant,

JOHN CORPE.

* Sixteen quarts of vital air, mixed with the ſame quantity of atmoſpheric air, were adminiſtered in the evening.

P. S. I

P. S. I had almoſt forgot to obſerve, that the door and windows of my dear child's room were kept almoſt conſtantly open, and, being exactly oppoſite to each other, naturally created a free circulation of freſh air.

Obſervations on this Caſe by Dr. Thornton.

Miſs Corpe, æt: eighteen when I ſaw her, was convulſed; and the nurſe ſaid, "that, if it was her child, nothing more "ſhould be given;" even her mother requeſted, "if there "really were no hopes, that ſhe might not be diſturbed by "medicine." What increaſed the alarm was: a tradeſman a few doors off had lately died of this ſame fever under this eminent phyſician, leaving behind him a widow and ſix children. The caſe, indeed, ſeemed deplorable; but deſpair ſhould never be allowed while there is life; and it authoriſed the exhibition of the vital air, which undoubtedly contributed much to the recovery of this amiable young lady.

XVII. *On the Glazing of Earthen Veſſels without Lead* *.

As it is well known that the common glazing by lead employed for earthen ware is of a pernicious nature and prejudicial to the health, H. Nieſeman, a potter at Leipſic, has propoſed the following:—Take nitre, pot-aſh, and common ſalt, of each half a pound, with double that quantity of pulveriſed glaſs, and mix them well together; then take a well baked flat earthen diſh, cover it pretty thick with well beat clay, ſtrew over the clay as much ſand as will adhere to it, and ſuffer it to dry. Put the above ingredients, well mixed, into this diſh, and introduce it into the furnace in order that they may be all fuſed together. The diſh, however, muſt be placed within another, in order that the ingredients may not be loſt in caſe the diſh ſhould happen to crack: but if it be well covered with clay carefully beſtrewed with ſand, little danger is to be apprehended. When the ingredients have

* From *Neue Sammlung œkonomiſcher Schriften.*

been

been fused, they are to be pounded very fine in the usual manner, and may be employed as the common glazing of lead. The colour of this glazing inclines a little to grey, but by the addition of the common calcareous spar it acquires a yellow colour: manganese gives it a brown colour; and the addition of copper ashes a green colour. To avoid, however, every thing that has the appearance of being pernicious, this mixture of copper ashes should be employed only for vessels which are to be used in washing. If this glazing is required for any particular purpose to be difficult of fusion, a little less litharge may be added to it; but the quantity in all cases must be so small as to leave no room for apprehending the least bad consequences. This substitute for the common glazing is strongly recommended by Professor Leonhardi.

XVIII. *Geographical Description of the Isles of France and Bourbon*.*

THE Isle of France was discovered in the fifteenth century by the Portuguese, who called it the Isle of *Acerno.* The Dutch took possession of it in the year 1598, and gave it the name of the Mauritius, in honour of their Stadtholder Prince Maurice. It was not, however, till the year 1640 that they formed a settlement there, at a harbour in the south-east, which they abandoned in 1712, either on account of the little progress it made, or on account of their establishment at the Cape of Good Hope. In 1715 the French landed at the harbour in the north-west side, and named the island *Isle de France.* Soon after, in 1721, the inhabitants of the Isle of Bourbon, at present called *Isle de la Reunion,* which is situated at the distance of about ninety miles to the west of the Isle of France, formed a new settlement under the direction of Durongay. During fifteen years this colony was in a very languishing condition. It was

* From Labarthe's *Annales Maritimes et Coloniales.*

rendered

rendered productive by La Bourdonnaie in 1735; and in 1764 the island was given up to the French government by the East India Company. After that period it was placed under the direction of a governor, and an intendant, or *ordonnateur*.

It lies in 20° 10′ of south latitude and 53° 24′ of east longitude from the meridian of Paris. According to La Caille it is 90,668 toises in circumference, 31,890 broad from east to west, and contains 432,680 square acres, each of 100 perches, and the perch of 20 feet. It has two harbours; one in the south-east, or the Great Haven, and the other in the north-west, called the Small Haven; also Port Louis, and, since the Revolution, *Port de la Montagne*. The most northern harbour is the principal port in the island. The north-west part of it is perfectly flat, but the south-east is covered with mountains; they are from 300 to 350 toises in height: the highest, at the mouth of the river Noire, is 424. The most remarkable mountain is called Pieterboth; it is 420 toises in height, and its summit ends in an obelisk, on which there is a large cubical mass of rock that no man has yet been able to ascend.

The island is watered by more than sixty streams, some of which, in the droughty season, become totally dry, especially since the forests have been cut down. The interior abounds with lakes, and rain prevails during the greater part of the year, the clouds being attracted by the mountains and forests. The soil is covered with large or small stones; it withstands the plough, and must be cultivated with the hoe, yet it is very proper for various productions. Though of less depth and less fertility than that of the Island of Reunion, it is however, in general, more susceptible of cultivation.

The Island of Reunion (Bourbon) was discovered also by the Portuguese, who called it Mascarenhas, after the commander of the fleet; and this name was afterwards corrupted into *Mascaraigne*. In the year 1642 Pronis, the commandant at Madagascar, took possession of the island for

the French government. Seven years after, this was repeated by the new commandant Deflaccourt, who gave the island the name of Bourbon. He introduced into it domestic animals, which multiplied considerably; and, on account of its fertility, several Frenchmen formed in it settlements. In the year 1665 two ships of De la Haie's squadron arrived here, and left Renaud, an *officer d'administration*, together with twenty labourers. The French who in 1671 escaped the massacre at Fort Dauphin, in Madagascar, fled to this island; and various sea-faring persons settled in it, and employed themselves in agriculture.

It is situated about ninety miles from the Isle of France, to the windward. One day only is sufficient for going from the Isle of France to the Isle of Bourbon, but a month is often necessary to return. It is about forty miles in length and thirty in breadth. The shores are exceedingly steep, and piroguas only can approach them without danger of being overset. The soil is sandier than that of the Isle of France: at some distance from the shore it is mixed with those smooth stones (*galets*) which cover the bottom of the sea. The ground, however, in those parts which can be cultivated, is excellent. The mountains are exceedingly high: the three inaccessible peaks, called the *Salasses*, are said to be 1600 toises. There is here a very awful volcano, the district around which is entirely burnt up; and also a great many gulleys, the declivities of which are so steep that they cannot be cultivated. The chief port in the island is that of St. Denis, where a drawbridge, secured by iron chains, has been constructed for the purpose of enabling boats to land. This bridge extends more than eighty feet into the sea, and at the end of it is a ladder of ropes by which people who wish to go on shore must ascend: in all other parts of the island they must jump into the water.

About fifteen miles to the windward from St. Denis is St. Paul, where the sea is calmer, and the anchoring ground more secure: mariners, however, prefer St. Denis. This

island

island produces annually 55,700 weight of corn, 54,300 of maize, and three millions of pounds of coffee. The most fruitful district of the island is that of St. Susanne, four leagues from St. Denis.

The sky is serene, the atmosphere pure, and the water salubrious. Land tortoises, which were here formerly so abundant, are found now only in the western part; in the other parts they have been exterminated by ships which have touched at the island. The wild goats and wild hogs have retired to the summits of the mountains: the rabbits, quails, partridges and pintadoes brought to the island have none of them increased, except the last. Le Gentil mentions as found here a bird called *l'oiseau bleu*, a very delicate kind of bats; among the vegetable productions, ebony, benjamin, the cotton shrub; a great deal of timber for ship-building; and among the fruit-trees, the guava, the banana, and orange and lemon trees in great abundance.

NEW PUBLICATIONS.

Commentationes Societatis Regiæ Scientiarum Gottingensis, &c. Transactions of the Royal Society of Gottingen, for the Years 1795—1798. Vol. XIII. quarto. *Gottingen*, 1799.

THE Physical Class of this volume, to which a preface by Professor Heyne is prefixed, contains the five following treatises:——M. Sömmering on an aperture in the centre of the retina of the human eye, observed in the body of a person who had been drowned.—M. Wrisberg on an unnatural conformation of the organs of generation in a boy.—Professor Gmelin's refutation of the grounds brought against the existence of phlogiston.—Dr. Lentin on the phosphoric acid as a cure for caries and rottenness of the bones.—M. Sömmering on the trunk of the lacteal ducts in the absorbing vessels lying on the aorta. The principal papers in the Mathe-

Mathematical Clafs are:——Kaftner on the external furface of the fcrew.—Klugel on a new conftruction of a compound object-glafs.—Kaftner on the content of the threads of the fcrew and the fpace between. In the Hiftorical and Philological Clafs are:——A paper by Profeffor Heyne, to fhew that there was no extinction and revival of the arts in the middle ages.—Profeffor Heeren on the diverfity and affinity of languages in the ancient kingdom of Perfia.—Gatterer's fourth treatife on the Sarmatian extraction of the Livonians.—Profeffor Heeren on the ancient form of the Perfian gulph.—Profeffor Heyne on the means of difcovering the earlieft ftate of Homer's poems, and of reftoring them.

Memorias da Academia Real das Sciencias de Lifboa, &c. Vol. I. from 1780 to 1788. Lifbon, 1797. Small folio. 575 pages.

THE Academy of Lifbon was indebted for its origin, in the year 1779, to the Duke de la Foes, uncle of the prefent queen, who is alfo prefident of it. The different branches of knowledge to which its attention is directed are: Natural Philofophy, Mathematics, and Domeftic Literature: and the Memoirs are divided into the fame number of claffes.

In the Phyfical Clafs are:—Domenico Vandelli *Floræ et Faunæ Lufitanicæ Specimen*, which is a mere nomenclature: *De Vulcano Oliffiponenfi et montis Erminii*, by the fame. The above two papers are in Latin, the reft in Portuguefe. Two papers by Joao Antonio Dalla Bella on the magnetic power. Various obfervations in chemiftry and natural hiftory, by Domingos Vandelli. Obfervations on a plant hygrometer, by Antonio Soarez Barbofa: this hygrometer is made of the twifted beard of the feed of a geranium. Phyfical obfervations in regard to the lightning which in different years had ftruck fome of the royal buildings at Mafra. Meteorological obfervations in various places by different men of learning. On the uncertainty of our knowledge refpecting the plant which produces myrrh, by Joao de Loureiro. On the nature and real

real origin of the *Agallochum*, from a plant entirely new, which the author calls *Aloexylum*, by the same.

In the Mathematical Class are:——A general solution of Kepler's problem *de demetriendo dolio non pleno*, by José Monteiro da Rocha. On the true principles of the doctrine of fluxions, by Borja Garçao Stockler. Additions to the rule of M. Fontaine for solving problems respecting the quadrature by approximation, by José Monteiro da Rocha. Various observations of the eclipses of Jupiter's satellites, made in 17[illegible], in the royal college of Mafra, by D. Joaquim da Assumpçao Velho. On determining the longitude and latitude of Lisbon, with the astronomical observations employed for that purpose, by Custodio Gomes de Villas-Boas. Observations of the same kind, and for the like purpose, made at Rio Janeiro, by Bento Sanches Dorta. Astronomical observations by Franc. Antonio Ciera and Franc. de Oliveira Barboza. Observations on the end of the eclipse of Dec. 17, 1781, made at Carthagena, by D. Jacinto Ceruti. Solution of a problem, proposed by the Royal Academy of Sciences, respecting the approximation of M. Fontaine, by Manoel Joaquim Coelho da Maja.

In the Class of Portuguese Literature a series of papers is announced on the legislation and constitution of Portugal, by Antonio Caetano do Amaral. The first, which is here given, contains an account of the state of Portugal till it became a Roman province. This class contains also the two following articles:—On the Pastoral Poetry of the Lusitanians, by Joaquim de Foros; and a historical elogium of D'Alembert, by Franc. Borja Garçao Stockler.

Philosophical Transactions of the Royal Society of London for the Year 1799. Part I.

The contents are:——I. The Croonian lecture. Experiments and observations on the structure of nerves, by Everard Home, Esq. F. R. S.—II. The Bakerian lecture. Observations upon an unusual horizontal refraction of the air, with

with remarks on the variations to which the lower parts of the atmosphere are sometimes subject; by the Rev. S. Vince, A. M. F. R. S. and Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge.—III. Abstract of a register of the barometer, thermometer, and rain at Lyndon, in Rutland, 1797; with some remarks on the recovery of injured trees: by Thomas Barker, Esq. Communicated by Mr. Timothy Lane, F. R. S.—IV. Some additions to a paper read in 1790, on the subject of a child with a double head: by Everard Home, Esq. F. R. S.—V. Observations on the manners, habits, and natural history of the Elephant: by John Corse, Esq. Communicated by the Right Hon. Sir Joseph Banks, Bart. K. B. F. R. S.—VI. On the decomposition of the acid of borax, or sedative salt: by Lawrence de Crell, M. D. F. R. S. London and Edinburgh, and M. R. I. A. Translated from the German.—VI. A method of finding the latitude of a place by means of two altitudes of the sun, and the time elapsed betwixt the observations: by the Rev. W. Lax, A. M. Lowndes's Professor of Astronomy in the University of Cambridge.—VIII. A fourth catalogue of the comparative brightness of the stars: by William Herschel, L. L. D. F. R. S.—IX. On a sub-marine forest on the east coast of England: by Joseph Correa de Serra, L. L. D. F. R. S. and A. S.

The Appendix contains a Meteorological Journal, kept at the apartments of the Royal Society by order of the president and council.

INTEL-

INTELLIGENCE,

AND

MISCELLANEOUS ARTICLES.

MIDWIFERY.

IN our Second Volume, p. 111, we announced a discovery said to have been made by Mr. Herholdt, an eminent accoucheur at Copenhagen, that the apparent death of new-born children arose from the trachea being filled with a liquid, and that they might often be restored by merely giving them a position favourable to its efflux. We then expressed a doubt as to the correctness of the observations; because it appeared impossible, from Dr. Goodwyn's experiments, that water could in any case enter into the trachea; and because, in those experiments in which it had been forced into the trachea, it had always been absorbed, if the animal was suffered to live. Candour, however, now calls upon us to state, that we find the following article in the Journal de Physique for Floreal, an. VII.

"An important discovery is announced in the Medico-chirurgical Journal, published by Professor Tode of Copenhagen *. Herholdt has found, on opening the bodies of still-born animals, that the cavity of the tympanum was filled with the liquor of the amnios and with phlegm (viscous water). This fluid after birth issues by the auditory conduit, and is replaced by atmospheric air. This discovery induced him to suppose that the liquor of the amnios is introduced also into the canal of respiration before the child is born. *Experiments made at the veterinary school have confirmed this hypothesis.* Nature, in general, discharges this liquor, but sometimes it is necessary for that purpose to employ the assistance of art. A child cannot breathe easily

* Vol. III. chap. 3. 1798.

until it is freed from it. Herholdt is of opinion, that this accident occasions more apparent deaths than is commonly believed. It is not sufficient then to rinse the child's throat; it must be placed in such an attitude as will facilitate the running off of the water. The author has had the good fortune this year to restore to life twelve children out of thirteen who were in the like situation. Professors Abildgaard and Wiborg have confirmed this experiment by opening five puppies cut from the belly of the mother."

NATURAL HISTORY.

The following incident has lately attracted much notice at Paris:—Citoyen Felix two years ago brought two lions, a male and female, to the national menagerie. About the beginning of June Felix fell ill, and could no longer attend the lions; another was forced to do his duty. The lion, sad and solitary, remained from that moment constantly seated at the end of his cage, and refused to receive any thing from the stranger. His presence even was hateful to him, and he menaced him by bellowing. The company of the female seemed also to displease him; he paid no attention to her. The uneasiness of the animal afforded a belief that he was really ill, but no one dared to approach him. At length Felix got well, and meaning to surprise the lion, he crawled softly to the cage, and shewed only his face against the bars; the lion in a moment made a bound, leaped against the bars, patted him with his paws, licked his hands and face, and trembled with pleasure. The female ran to him also; the lion drove her back, seemed angry, and fearful that she should snatch any favours from Felix; a quarrel seemed about to take place between them, but Felix entered the cage to pacify them. He caressed them by turns. Felix is now seen frequently in the midst of this formidable couple, whose power he has fettered: he holds a kind of conversation with them. Does he wish that they should separate and retire each to their cages, he has only to speak a word; does he wish that they should lie down to shew strangers their paws armed with

terrible

terrible claws, and their throats full of tremendous teeth—at the leaſt ſign from him they lie on their backs, hold up their paws one after another, open their throats, and, as a recompence, obtain the favour of licking his hand.—Theſe two animals, of a ſtrong breed, are five years and a half old; they were both of the ſame mother, and have always lived together.

FULMINATING OXYD OF MERCURY.

It is well known that C. Bayen, Brugnatelli, and others, ſome time ago diſcovered that nitrats in general, thoſe of the metals not excepted, detonate with combuſtible ſubſtances, eſpecially with ſulphur. That ſome preparations of gold and of ſilver poſſeſs the property of fulminating without the addition of any inflammable ſubſtance, has alſo been known for ſome time. We have now to announce, that a method of preparing an oxyd of mercury, different from any deſcribed by Bayen or others, that may be fired like gunpowder, and detonates loudly with a gentle ſtroke of a hammer, has juſt been diſcovered by Mr. Edward Howard. We have not yet received a correct account of the proceſs for preparing it, but, from the wonderful expanſive force it exerts on being fired, we have not a doubt that it will prove a very uſeful diſcovery. A few grains of it tried in a gunpowder proof, inſtead of merely raiſing the flap to ſome point within the range of the attached ſcale, fairly ſhot it off; and the piece detached, on being examined, was found to have received ſuch a blow from the newly-generated gas as to be abſolutely dented by it, as if it had received the impreſſion of a punch by means of a heavy hammer: the cavity was exactly the diameter of the bore of the proof, and, what is extremely ſingular, of an equal depth all over. A charge of only thirty-two grains laid open, for two inches in length, the breech-end of a very ſtrong muſket barrel on the two oppoſite ſides, the force being too great to allow time to the gas to wiredraw itſelf (if we may

ufe the term) to enable it to pafs off through the calibre.
—In a future Number we fhall lay farther particulars before our readers refpecting this difcovery.

EFFECT OF HYDROGEN GAS ON THE VOICE.

The Journal Britannique, publifhed at Geneva by Prevot, contains the following article:—" Maunoir was one day amufing himfelf with Paul at Geneva, in breathing pure hydrogen air. He infpired it with eafe; and did not perceive that it had any fenfible effect on him, either in entering his lungs, or paffing out. But after he had taken in a very large dofe, he was defirous of fpeaking, and was aftonifhingly furprized at the found of his voice, which was become foft, fhrill, and even fqueaking, fo as to alarm him. Paul made the fame experiment on himfelf, and the fame effect was produced. I do not know whether any thing fimilar has occurred in breathing any of the other gafes."

CHEAP METHOD OF PREVENTING THE DISAGREEABLE SMELL OF PRIVIES.

In fome houfes, privies, when badly placed and ill taken care of, diffufe an odour as inconvenient as unhealthful; but the means of remedying this evil is exceedingly eafy. If a certain quantity of milk of lime (water in which lime has been diffolved, and whitened by the fine particles of that fubftance) be mixed with a ley of afhes, or foapy water that has been even ufed for wafhing, be thrown into the fink of the privy, it will deftroy the offenfive fmell. By thefe means, for the value of a few pence, any collection of filth whatever may be neutralifed. By the fame procefs conveniencies for fick perfons may be kept in their apartments. Nothing is neceffary but to have a tub covered with a board as a feat; five or fix pounds of quicklime, a fmall quantity of afhes, and two buckets of water thrown into the tub, will prevent any difagreeable odour. It may readily be conceived that the fame procefs may be employed in regard to a night-

 chair.

chair. The fecal matter, after being thus neutralifed, is an excellent manure for land.

LENGTH OF THE METRE.

From the Journal de Phyfique we learn, that the report which has been made of the length of the metre at Paris by the learned men employed in determining the length of a degree of the meridian, has been fixed at 3 feet 11 lines and 1,296 of a line. On this bafis all the other meafures are to be formed. We fhall give hereafter a more particular account of this operation, which leads to fome changes in the refults before given by approximation.

TRANSIT OF MERCURY.

"I waited with impatience for the paffage of Mercury over the fun's difk in his defcending node. It had never been completely obferved in that pofition, and there will not be another for thirty-three years. I had the pleafure of obferving Mercury enter the fun's difk, like a fmall round black fpot, on the 18th of Floreal (May 7th) in the morning, at the very moment pointed out in my new tables. The principles on which they are founded I have explained in the firft memoir read at the firft meeting of the firft clafs of the Inftitute immediately after its eftablifhment. This is the more fatisfactory, as, in the calculations for the tranfit of the 4th May 1780, there were forty minutes variation from the beft tables of Mercury. LALANDE."

PREPARATION OF BRUNSWICK GREEN.

Kafteleyn has lately publifhed the following method of preparing this colour, which is much ufed on the Continent for oil painting, and in the manufacturing of printed paper. Shavings of copper are put into a clofe veffel, and befprinkled with a folution of the muriat of ammonia. The metal firft unites with the muriatic acid, and is diffolved, and is in its turn precipitated by the difengaged ammonia, to which it now joins itfelf. The precipitate is then wafhed

and dried in wooden boxes, or upon an extended cloth. The liquid which remains, as well as the water of the firſt waſhing, may be employed ſeveral times in ſucceſſion for new operations, by diſſolving in it freſh portions of ſal ammoniac to the point of ſaturation. Three parts of the muriat of ammonia are ſufficient for two parts of copper, and the reſult is ſix parts of colour. This beautiful green is in Holland called Frieſland green. It is almoſt always adulterated with ceruſe.

CEMENT FOR FILLING UP CRACKS AND FISSURES IN IRON VESSELS.

The ſame author has alſo made known this cement. It conſiſts of ſix parts of yellow potter's clay, one part of the filings of iron, and a quantity of linſeed oil ſufficient to form the whole into a paſte of the conſiſtence of putty.

GREN'S EUDIOMETER.

Profeſſor Gren, in a work of his lately publiſhed *, propoſes the following method of conſtructing an eudiometer by means of phoſphorus; which, though ſlow in its operation, will give a very accurate reſult. Take a ſmall cylindric glaſs tube, ſealed at the one end, and divided from that end by means of a ſcale into ſufficiently ſmall equal parts; fill it with diſtilled water, plunge it into a baſon of the ſame liquid, make to aſcend a quantity of the air to be examined, and note the ſtate of the atmoſphere at the time, as indicated by the barometer and thermometer. Through a cork, ſmaller in diameter than the tube, ſtick a few needles, and place on the upper end of them a bit of pure clear phoſphorus: faſten a thread to the bottom of the cork. Introduce this cork into the lower end of the tube, with the phoſphorus uppermoſt, in which it will riſe to the ſurface of the water; ſo that the phoſphorus on the needles will come in contact with

* Grundriſs der Naturlehre. Halle, 1797.

the gas in the upper end of the tube. The tube muſt now be left inverted in the veſſel filled with water, in which it muſt remain. The phoſphorus will undergo a ſlow and gradual combuſtion: by means of the thread the cork from time to time may be drawn under the water to waſh off the acid produced by the combuſtion, and, adhering to the phoſphorus, to haſten the proceſs. When all the oxygen gas is conſumed, and the remaining phoſphorus is no longer obſerved to ſhine in the dark, the cork muſt be drawn out; and the obſerver muſt note, at a correſponding height of the barometer and degree of heat with that of the atmoſphere when the proceſs commenced, the quantity of azot remaining, and how much oxygen has been conſumed.

METHOD OF PROVING WHETHER COTTON BE ADULTERATED WITH WOOL, or *vice verſa.*

You may eaſily aſcertain whether cotton is mixed with wool, by ſubjecting it to the action of the oxygenated muriatic acid, which will render it white, at the ſame time that it makes the wool yellow. Profeſſor Brugman, of Leyden, has by the ſame means been able to determine with certainty what part in the brain is the medullary ſubſtance, and what part the nerves; and to diſcover the latter even at their origin, where moſt concealed.

OXYGENATION OF SNOW AND RAIN.

In our laſt volume, page 233, we gave a paper by M. Haſſenfratz on the oxygenation of ſnow and rain, and their effects on vegetation. In that paper M. Haſſenfratz divides the action of ſnow into parts. 1ſt, As preſerving plants from the great cold of the atmoſphere; 2d, as cauſing a greater number of ſeeds to expand by means of the oxygen with which it ſupplies them. M. Haſſenfratz proved the preſence of oxygen in ſnow by its rendering turnſol paper red, and precipitating oxyd of iron from a ſolution of the ſulphat of that metal. Dr. Joachim Carradori de

de Prato has, however, lately asserted *, in opposition to M. Hassenfratz, that snow is not oxygenated: 1st, because fish which lived very well in common water, did not live in recent snow water, but died in a short time: 2d, because snow water exposed to the action of light did not suffer oxygen gas to be disengaged. He ascribes therefore the sudden death of fish, and the non-production of oxygen by light, to the want of that substance in snow water. M. Hassenfratz has observed, in answer to these objections, that animals may die either through the want or by an excess of oxygen, as well as by the want or an excess of nourishment, and that a mean proportion of both are necessary for the preservation of life and health: that all oxygenated substances do not disengage their oxygen on being exposed to the light; and that when it is disengaged, they suffer only the excess to escape—another portion remains which cannot be taken from them by that agent. Dr. Carradori," says M. Hassenfratz, "does not deny the results of the experiments I have announced; he only thinks they are not conclusive, because fish do not live in recent snow water." He therefore promises, as soon as he can procure snow water, to repeat Dr. Carradori's experiments; to vary them, and make new ones, in order to prove in the most positive manner the existence of oxygen in snow, and to determine the causes of the phenomena which seem to belong to it exclusively.

EUROPEAN SUGAR.

We are informed by Professor Beckmann, that the Chamber of the Mark at Berlin has lately been at great pains to promote the manufacturing of sugar from plants indigenous in Germany. Some experiments were made for that purpose with the juice of the maple, which was refined in a sugar bakehouse, and found to be equal to loaf sugar. Professor Beckmann, who saw specimens of it, says, it has been found

* See his experiments in the *Journal de Physique*, Ventose, an. 7. p. 226.

that

that the Virginian red maple, or ſilver-leaved maple (*acer rubrum*), gives more ſugar than the ſugar-maple (*acer ſaccharinum*); which is the more fortunate, as the latter withſtands better the cold of an European winter. The Profeſſor adds, that attempts are making in Brandenburg to cultivate this tree, and that ſeeds have been ordered from America, but they have not yet arrived.

ERUPTION OF THE PEAK OF TENERIFF.

Fleurieu lately announced to the National Inſtitute, that a ſea-captain had actually ſeen the Peak of Teneriff throwing up fire. According to La Cepede, no eruption from the Peak has taken place for 400 years. Fleurieu himſelf had often ſeen ſmoke ariſe from it, and found the earth near the crater ſomewhat warm.

TORNADO.

The following account of a phenomenon of this kind, which took place at Whitelaw, in the pariſh of Ednam, Berwickſhire, on the 3d inſtant, is copied from the Kelſo Mail:—

"The weather through the day had been calm, with ſoft ſhowers. At ſeven o'clock in the evening there was obſerved by many people, a little to the ſouth-weſt of Mr. Tod's houſe at Whitelaw, a denſe light-coloured cloud of a very uncommon appearance. It reſembled an inverted cone, reaching from the ground to a conſiderable height in the atmoſphere. Its motion towards the houſe was ſlow and majeſtic; a perſon of no great agility, on ſeeing it approach, could eaſily have eſcaped from it. It began at length to whirl round with great rapidity, accompanied by a loud rattling noiſe. The effect of its amazing power was firſt exhibited upon a large ſtack of ſtraw in the barn-yard, which it raiſed in one maſs to a conſiderable height in the air. A beam of timber, lying flat on the ground, was hurled from its place ſeveral feet; and it will be thought almoſt to exceed credibility when it is mentioned that this beam was 33 feet long. Small ſtones were heaped

together

together in mounds, as if by a flood. The farm offices were materially injured; fome of them, indeed, were almoft entirely ftript of their tiles. Human ftrength was mere weaknefs when oppofed to this war of the elements. A ftout young fellow, who had witneffed the fcene in the barn-yard, from an apprehenfion that the houfe muft neceffarily be tumbled down, ran out for fafety. The refiftlefs enemy, however, lifted him over a wall five feet high, and carried him forwards 30 or 40 yards! Several of the fervants were forcibly driven about, fome in one direction and fome in another, according to the eddy. The horfes and cattle upon the farm exhibited the livelieft fymptoms of alarm and agitation. The dwelling-houfe at Whitelaw, in which the family refided at the time, fhook with fuch violence as to threaten its own deftruction and theirs. Providentially, however, amidft all the devaftation, no perfon was materially hurt; and, what renders this the more remarkable is, that the tiles which were torn from the furrounding offices fell from an immenfe height, in vaft numbers, among the people expofed to the ftorm. Before the cloud reached the farm-houfe it had fortunately divided, and the two parts taking different directions, only one of them ftruck the buildings. Had the whole collected force difcharged itfelf at once, few, it is probable, would have furvived to relate the particulars. There was little rain at Whitelaw either immediately before or after the whirlwind; but in the adjacent country, to the north and eaft, owing, it is fuppofed, to the violent concuffion of the clouds, there was fuch a torrent of rain, and, in fome places, of hail for a few minutes, as had not been obferved in the memory of man."

DEATHS.

After a few hours illnefs, on Saturday July 6th, at his houfe in Oxford-ftreet, Revely the architect; a man of great attainments in his fcience. He had followed the fteps of Athenian Stuart in his travels through Greece and refidence

refidence at Athens, and had availed himfelf of all the advantages which might be derived from vifiting the architectural remains in that part of the eaft. His collection of drawings, which were made during his oriental progrefs, are univerfally known to all the lovers of art and admirers of claffic antiquity.

His principal work is the New Church at Southampton, which poffeffes great merit as it is; and would have been a very diftinguifhed monument of his talents, if his original defign had been completed; but he was curbed and controuled in its progrefs by his employers, the mayor and aldermen of that borough.

His plans for wet docks on the Thames, which were offered to the confideration of Parliament, difplay a very comprehenfive knowledge of the various branches of his profeffion connected with fuch an undertaking. We have heard that he firft fuggefted the converfion of the Ifle of Dogs to that ufe to which there is an appearance that it will now be applied. Thefe plans he fometimes thought of publifhing, with large explanations and technical accounts of every part; but we know not how far he had proceeded, or whether he had proceeded at all, in fulfilling fuch an intention.

He was once tantalized with the flattering expectation of being employed at Bath in erecting a fuite of buildings for a new arrangement of the public baths in that city. He accordingly made defigns of great beauty and elegance, replete with convenience, full of rare contrivance, and difpofed in an original ftyle of accommodation. But this hope paffed away, as Mr. Revely's hopes were very apt to do. He was alfo the Editor of the pofthumous volume of Stuart's Antiquities of Greece, and was peculiarly qualified, by his local and profeffional knowledge, for that office.

He had been a pupil of Sir William Chambers, and, with all the fubfequent advantages derived from travel and refidence in Italy and Greece, it might have been fuppofed that he had a very fair profpect of fuccefs in his profeffion. But

Revely had an awkward way of letting loofe his real opinions, and had habituated himfelf to an undifguifed delivery of them. It need not be added, that fuch qualities were not calculated to render him popular, and that they influenced many who were difpofed to employ him to feek architects of more pliant and accommodating difpofitions.

He entertained a very high opinion of the profeffion of an architect; but it did not check his induftry by any fupercilious affectation of importance, for he fought employment wherever a liberal fpirit would permit him to feek it. This activity, however, appears from fome untoward circumftance or other to have been continually baffled. He once made a journey to Canterbury, with a fet of admirable defigns for a county infirmary, in confequence of an advertifement from the corporation of that city, which invited architects to make propofals for the erection of fuch an edifice. His defigns were approved and admired; but after fome confideration, the committee appointed to conduct the bufinefs propofed to purchafe the drawings, and truft the execution of them to a country builder in order to fave the expence of an architect. Mr. Revely, mortified at this treatment of his profeffional character, rather warmly, but very innocently obferved, that to commit a work of fuch confequence to a common carpenter, when an architect was at hand, would be as injudicious as if any one, in a cafe of great danger, fhould apply to an apothecary when he could confult a phyfician. Now, it moft unfortunately happened that the chairman of the committee was an apothecary; and Mr. Revely was aftonifhed to find himfelf and his defigns very unceremonioufly difmiffed, to make room for a builder who probably was not qualified to fuggeft fuch frivolous diftinctions.

We cannot conclude without giving this accomplifhed architect the beft praife that can be beftowed. He was a man of ftrict integrity in all his dealings; and the little eccentricities of his character had no tendency to weaken the main fupporters of it.

In

In Vol. III. p. 335, we announced the death of the celebrated French aſtronomer Borda on the 20th of February laſt in the 64th year of his age. Since that period we have been able to collect a few more particulars reſpecting the ſervice rendered by him to the ſciences, which will no doubt afford ſatisfaction to many of our readers. Charles Borda, formerly Chevalier de Borda, was a *Chef d'Eſcadre* in the Royal Navy under the old French government. He diſtinguiſhed himſelf early as an able mathematician, and many proofs of his talents in this reſpect may be found in the numerous and excellent papers which he publiſhed in the Memoirs of the Academy of Sciences. He wrote on different objects of hydraulics; on the reſiſtance of fluids; on water-wheels and pumps; on the throwing of bombs; on the method of determining curved lines; on the properties of *maxima* and *minima*; on the beſt method of chooſing by lot. In the year 1771 and 1772 he undertook a voyage, by command of the king, with Verdun de la Crenne and Pingré, in the Flora frigate, in which he had the rank of *Lieutenant de Vaiſſeau*, to various parts of Europe, Africa, and America, for the improvement of geography and navigation, and in order to try various nautical inſtruments and time-pieces. Theſe three navigators afterwards publiſhed, in concert, the reſult of their obſervations, in two volumes quarto, under the title of *Voyage fait par Ordre du Roi en* 1771 *et* 1772, &c. in which Borda's ſhare was not the leaſt conſiderable. An account of the reſult of this expedition may be found alſo in the Memoirs of the Academy of Paris for the year 1773. The public are indebted to him likewiſe for the beſt chart of the Canary Iſlands, which ſerved as a pattern for the valuable chart of theſe iſlands publiſhed in Spain in 1788.

In the year 1787 he publiſhed his valuable *Deſcription et Uſage du Cercle de Reflexion*, in which he revived the reflecting circle propoſed by Tobias Meyer in 1756. He was the founder of the firſt ſchool for Nautical Architecture in France, and drew up a plan of the mode of education to be employed

employed in it. He introduced alſo an uniformity in ſhip-building according to the principles of Euler, by which means all the French ſhips of war were ſo conſtructed as to be equal in point of ſailing. The form of the French ſhips, which is founded on true mathematical principles, is undoubtedly ſuperior to that employed by other maritime nations: it is the moſt convenient and advantageous for quick ſailing, as has been acknowledged even by ſome of the beſt officers in the Britiſh Navy. He brought into uſe Meyer's old method of meaſuring terreſtrial angles, which had been totally neglected; employed it in aſtronomical obſervations, and invented a circle on a new conſtruction with moveable teleſcopes, which was uſed in the new meaſurement. He was the inventor of the new inſtruments with which that meaſurement was made, and of which ſome account has been given in the firſt volume, p. 269, of this Magazine. He had the greateſt ſhare in the late reform of weights and meaſures introduced in France; and cauſed to be printed, at his own expence, tables of ſigns according to the decimal ſyſtem. In the year 1792 he determined, with an accuracy never before attained, the length of a pendulum ſwinging ſeconds, at Paris. In the year 1797 he ſtood on the liſt of candidates for the directorſhip.

The following anecdote is related of him when a young man:—Having preſented himſelf before Camus, who examined the ſtudents in the Artillery School, as a candidate for admittance into the Royal Artillery, he was rejected on the ſcore of incapacity. It was not long, however, before he was a colleague in the Academy of Sciences with his former examiner, who had entertained ſuch a falſe opinion reſpecting him. Borda, however, either through a love of truth, or reſpect for his *quondam* judge, who was now his fellow-member, always contradicted this anecdote, and called it an idle rumour.

Errata. In our laſt Number, p. 89, l. 14, *for* three *read* two. Page 90, 4th line from the bottom, *read*—that appear as if upon his body, and having, &c. Page 92, l. 23, *for* milla *read* metal.

THE

PHILOSOPHICAL MAGAZINE.

AUGUST 1799.

I. *Obſervations on the Property aſcribed to Oil, of calming the Waves of the Sea.* By I. F. W. OTTO *.

AN idea was entertained, in the earlieſt ages, that there were means capable of calming the waves of the reſtleſs ocean, and of rendering its ſurface tranquil and even. Ariſtotle ſays, that every body thrown into the ſea when agitated, ſuch as anchors, &c. tends to leſſen the waves; becauſe a kind of eddy is thereby created, which exerts itſelf in a direction contrary to their movement, and conſequently weakens them. Plutarch † and Pliny ‡ aſcribe this power to oil; as they aſſert that it poſſeſſes a property by which it reſtrains the reſtleſs movement of water, renders its ſurface even, and thereby cauſes the rays of the ſun, which are refracted through the waves in different directions, to paſs to the bottom free and uninterrupted. What the ancients have ſaid on this ſubject is exceedingly vague and obſcure. It does

* From Von Zach's *Geographiſche Ephemeriden*, Vol. II. Part 6.

† Quæſt. Nat.

‡ Ea natura eſt olei, ut lucem adferat et tranquillet omnia, etiam mare, quo non aliud elementum eſt implacabilius. *Hiſt. Nat.* lib. ii. c. 103.

does not appear clearly from their information, whether the divers, to whofe teftimony they refer, made their obfervations at the furface of the water, or at any depth. Befides, we are not able to afcertain whether they looked through the oil as through a window, or as through a magnifying glafs: for if a drop of limpid oil be let fall upon water, it will form a very fimple kind of microfcope, and magnify objects placed at a convenient depth below the water. Plutarch feems to believe, that the oil fpouted from the mouth of the diver formed, in afcending, a kind of canal, which facilitated the paffage of the light through the water *.

Of this property of oil, apparently fo wonderful, many teftimonies were afterwards produced; and it was even confecrated by fuperftition for this purpofe. Thus we are told, among the miracles of St. Cuthbert, that he gave a prieft, for a fea voyage, fome confecrated oil, by which he was enabled to allay the fury of the waves during a dreadful ftorm. Erafmus was acquainted with this property †; and at prefent it is not unknown among feamen, particularly in Holland.

Not many years ago, but before the celebrated Franklin communicated to the public his obfervations on this fubject, the following article appeared in the *Annual Regifter*:—"At the late fire in Thames-ftreet it was obferved that the oil, which, to prevent the farther fpreading of the fire, had been thrown into the river, vifibly calmed the violent agitation of the water. This property of oil," fays another paragraph, "appears to have been long known. It is ordered, by an old marine law, that when goods, during a ftorm, muft be thrown overboard, if any part of the lading confifts of oil, it fhall be the firft article thrown into the fea." In modern times we have a number of experiments which feem to leave no doubt refpecting this circumftance. I fhall

* Canifius Lect. Ant. Vol. II. p. 8. ed. Bafn.

† His words are: Nonnulli procumbentes in fabulas adorabant mare, quicquid erat olei effundentes in undas. *Colloq.* e recenf. P. Rabi. Ulm. 1747-8, p. 262.

here

here give an account of the moſt ſtriking of them, without any fear of being thought too circumſtantial, as experiments of this kind ſhould all be deciſive.

The inhabitants of the Bermudas employ oil in their fiſheries, in order to render the water of the ſea clear and tranſparent; and the Portugueſe ſailors, when they find the waves too violent on their entering the Tagus, pour a few flaſks of oil into the water, by which means it is rendered calm, and their entrance becomes eaſy. The divers in the Mediterranean, when they labour under water, and when the ſun-beams are prevented from penetrating to them by ſmall waves, are accuſtomed to ſpurt a little oil from their mouths. One Gilfred Lawſon, who reſided ſeveral years at Gibraltar, relates, that the ſeamen of that place were accuſtomed to pour a little oil into the ſea, in order that they might thereby be enabled to diſtinguiſh the oyſters at the bottom; and that the ſame practice was followed on the whole Spaniſh coaſt. The ſame thing is done on the coaſt of Provence, and alſo by the inhabitants of the Hebrides. The Raguſans, with the like view, are accuſtomed to ſprinkle oil over the water with a bruſh; and they give to the drops, under which the water becomes tranſparent, the name of windows. Tys Tiremann, a Dutch mariner, made an experiment of this kind during a ſtorm, after he had loſt his rudder and ſome of his ſails, and, with ſix half ankers of oil, calmed the fury of the waves. A lieutenant of the name of May obſerved in 1735, during a ſtorm, that the ſea was calm and ſmooth around two ſhips laden with caſks of oil, ſome of which were leaky; and an experienced ſeaman, named Bewerwyk, recommends, for ſecuring boats which might be ſent to the aſſiſtance of ſhips in diſtreſs, to throw into the ſea, oil and other fat ſubſtances, and even beer. In a deſcription of the ſhipwreck of a veſſel called the Anna Cornelia, this property of oil is alſo celebrated; and ſome experiments made at Portſmouth, in the time of a ſtorm, were attended with the beſt ſucceſs. In the year 1736 Detouches de la Frenaye

ſaw an old ſailor, by this method, ſave a ſhip which was on the point of foundering. One Day was indebted for his own ſafety, and that of his ſhip, to half a ton of oil. Linnæus* learned from Gronovius, that the Dutch captains who frequented Greenland, and who were reproached with concealing this property of oil, always carried ſome caſks of it with them when they went to the whale-fiſhery. The fiſhermen of the Texel carry oil with them for the like purpoſe. There is an inſtance of a herring-buſs being ſaved by pouring out oil; while another, at the diſtance of two or three hundred fathoms, went to the bottom. Not only oil, under which is to be underſtood fat oil, ſuch as olive oil, oil of rape-ſeed, and linſeed oil, may be employed for this purpoſe; but alſo fat animal fluids, ſuch as train-oil, &c. Ethereal oils do not poſſeſs the ſame property: a ſhip, for example, laden with oil of turpentine, which ſhould employ it with the like view, would certainly fail in its end. This oil, however, diffuſes itſelf very ſpeedily over the ſurface of the water; but the covering it forms is ſo thin that it is ſeparated by the ſmalleſt external force.

At Yarmouth the ſailors are unanimouſly of opinion, that fat ſubſtances thrown into the ſea prevent the agitation of the waves. Pennant † mentions an obſervation made reſpecting ſeals by the fiſhermen in Scotland. When theſe animals eat any fat fiſh, the ſea in their neighbourhood is uncommonly ſtill; a circumſtance which induces them to ſearch for them in ſuch places. Sir John Pringle learned in Scotland, that the fiſhermen could diſcover at a great diſtance places much frequented by herrings, as the ſea, by the oily fatneſs which theſe fiſh emit, has no apparent movement. It is obſerved at Rhode Iſland, that the water in the harbour of Newport is always calm and ſtill as long as the Greenland ſhips remain there at anchor. The cauſe of this is aſcribed

* Reiſe durch Weſtgothland, p. 304.

† Britiſh Zoology, Vol. IV.

to

to the ſea-nettle, a kind of vegetable ſea-worms from oily ſubſtances, which are thrown together in the hold of the ſhips, and the oil that oozes through between the ſtaves of the caſks, which, of courſe, is pumped out with the bilge water. Seamen have alſo obſerved, that the motion of a ſhip, the bottom of which has been newly payed, occaſions much leſs agitation in the water than that of another which has not been daubed over with tar for a long time. Such inſtances, of which ſeveral more equally deciſive might be produced, are ſufficient to authoriſe this uſe of oil, in oppoſition to thoſe who pretend that it can be employed only in ponds and other pieces of water of ſmall circumference, where, by diffuſing itſelf over a maſs of water not much ſwelled up, it can eaſily produce a tranquil ſurface.

Theſe facts ſeem to have been unknown to Dr. Franklin until he had an opportunity of making ſimilar obſervations himſelf. On his paſſage from England to America ſome perſon told him that he had thrown into a lake a veſſel containing oil in which flies had been drowned; that the flies, which were apparently dead, began in an inſtant to move, and went round with a circular motion on the ſurface of the water. Dr. Franklin aſcribed this movement to a repulſive power maintained by the oil, which gradually iſſued from the ſpongy bodies of the flies. In the year 1757, being at ſea in the middle of a fleet conſiſting of ninety ſhips deſtined for Louiſburg, he obſerved that the movement of the water was in one part of the fleet calm and uniform, while the water between the other ſhips was thrown into great agitation by the wind. As he could not at that time diſcover the cauſe of this phenomenon, he aſked the captain of one of the ſhips, who replied, that the cook had, no doubt, thrown out the greaſy water, which muſt have rendered the ſides of the ſhip oily.

Franklin now paid more particular attention to this circumſtance; and as he found that a drop of oil diffuſed itſelf

 ſpeedily

fpeedily over a large fpace of water, fo that it formed a thin covering to it, which reflected prifmatic colours, he refolved to make fome farther experiments; and though they did not all fucceed according to his wifh, he declared himfelf convinced of the truth of the phenomenon.

One of thefe experiments I muft here mention; for, though it does not appear very favourable to his ideas refpecting the efficacy of oil in calming the waves, it at any rate fhews that oil has a great influence on the motion of water. He difcovered that oil excites on the water a kind of waves, under circumftances when neither water alone nor oil could produce the like. He fufpended a glafs half filled with water, and having made it to fwing backwards and forwards, after the manner of a pendulum, the water remained at perfect reft. The cafe was the fame when the glafs was half filled with oil; but as foon as he had poured oil upon the water, and continued the fwinging of the glafs, the furface of the vibrating oil remained fmooth and even, while the water below it was thrown into a regular agitation like that of the billows of the fea.

Franklin confiders this phenomenon, which I have confirmed by experiments, to have in it fomething fingular, and difficult to be explained. The caufe of it, however, may perhaps lie in the difference of the fpecific gravities of thefe two fluids, by which they are fufceptible of the impulfe to movement in different degrees; and by the effort which the oil makes, on account of its lightnefs, to occupy the upper place on the furface, the water is violently agitated.

When a drop of oil is poured upon water in a ftate of reft, as for example in a bafon, a fine vapour immediately arifes and covers the furface of the water. It emits coloured rays, and difperfes fmall bits of paper thrown upon the fpreading drops. When the fpace on which the drop falls is fmall, it does not fpread itfelf; but feems, as it were, to be attracted towards its centre. When a bit of paper, twifted together

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in a conical form, and ſoaked in oil, is thrown into water, the fluid which iſſues from it cauſes it to turn round with a rotary motion on its centre.

In an experiment which Franklin made on a ſmall lake, the ſurface of which was raiſed into large waves by the wind, the oil ſpread itſelf with great velocity, but it did not moderate the waves. The reaſon of this was, that he poured out the oil at the leeward ſide of the lake. He therefore went to the windward ſide, where the waves originated; and there a ſmall quantity of oil produced, in the ſpace of ſeveral ſquare rods, a calm, which gradually extended farther until it reached the other end of the lake; and this whole part of it, for the extent of half an acre, ſoon became as ſmooth as ice.

Of the various explanations given of this phenomenon, the following appears to be the moſt natural, if not altogether ſatisfactory:—The air and water have an affinity for each other, and they unite in a mechanical and chemical manner when they come in contact. It is well known that air always exiſts in water; that the latter can be freed from it under the receiver of an air-pump; and that, when the water is again expoſed to the air, it abſorbs a like quantity of it. When a maſs of air preſſes, therefore, on the ſurface of a body of water, it combines itſelf in part with it, and forces it along with it. Now, if oil be poured upon water, the particles of the former attract each other with too great force to admit of their uniting with the water or the air. By the covering which the oil forms on the ſurface of the water, the latter is prevented from coming into contact with the air; and the wind is conveyed over its ſurface, without being able to force its way into it, and to raiſe it into waves.

The ſpreading of oil in water is aſcribed by Dr. Franklin to a repulſive power which they both exerciſe againſt each other; but it is very evident that this explanation is far from being ſatisfactory. Even if ſuch a power actually exiſted, and if the particles of the oil exerciſed a repulſive power

againſt the water, and an attractive power among themſelves, they would be prevented from ſpreading, in an uniform manner, over the ſurface of the water: they would rather form inſulated globules; and, as they touch the water, would equally recede, and proceed towards the bank or any other ſolid body. Oil, therefore, as it is lighter than water, muſt float on its ſurface when poured upon it, and, according to the laws of hydroſtatics, endeavour to extend itſelf in a lateral direction; and on account of the ſtrong adheſion of its particles, muſt form an extraordinary fine and continued ſtratum on the ſurface of the water. This diffuſion, however, ſuppoſes that the ſurface of the water is horizontal: it therefore ſeems to follow, that the whole power of the oil conſiſts in preventing the formation of new waves in the places on which it has been poured; but that it cannot be in a condition to diſperſe thoſe which have been already formed. The billowy agitation of water ſuppoſes that ſome part of its ſurface has been previouſly raiſed. Bodies which float upon it oppoſe this riſing by their gravity, conſequently the billowy movement, and in part deſtroy it.

It appears therefore, to ſome philoſophers, that this celebrated property of oil does not conſiſt ſo much in its fluidity and toughneſs, as in its being a lighter body than water. From this it would follow, that all bodies lighter than water, and at the ſame time more diſtended, ſuch as drops or maſſes formed by oil, muſt produce the ſame effect, but in a higher degree. Achard recommends for this purpoſe cloſe leathern veſſels, through which the water cannot penetrate; or, what would be ſtill better, tin-plate boxes of from ſix to eight feet content in the baſe and two feet in height, which muſt be filled with air, but rendered impenetrable to water. Ships, he thinks, without much increaſing their lading, might always carry with them ſome dozens of theſe veſſels or boxes, to be thrown overboard, faſtened to the ſhip with ropes, in caſe the agitation of the water ſhould threaten danger. Achard made experiments, on a ſmall ſcale, with tin-plate boxes of

this kind, which were attended with the wifhed-for fuccefs as when he employed oil: we know alfo, from the information of Scheldenung, that the whirlpool of the Maelftrom has been moderated by throwing pieces of wood into it.

To form a decifive opinion refpecting the utility of thefe means, it would be neceffary to make experiments upon a large fcale. At prefent oil appears to me to deferve the preference, as it produces the effect, not only by its being a lighter body, but alfo by its fluidity and toughnefs: befides, it poffeffes this advantage, that a fmall quantity of it is fufficient to fpread over a confiderable furface of water.

It has been objected againft this ufe of oil, that the calmnefs produced by it has been obferved to be only of fhort duration, and that the fea afterwards redoubles its fury: alfo, that a veffel which follows a fhip failing through water calmed by the above means, is expofed to fo much greater danger; but of this circumftance no teftimony of fufficient authority has been adduced *.

II. *Communication from Dr.* Mitchill, *of New-York, fhewing the Utility of conftructing the Houfes and paving the Streets of Cities with calcareous in preference to filiceous and argillaceous Materials.*

SIR, *New-York, June* 6th, 1799.

IF you think the inclofed letter of any importance, I wifh you would infert it in the Philofophical Magazine. It is fo

* Tranfactions of the Society of Manchefter, Vol. II. Achard's *Sammlung phyfikalifcher und chemifcher Abhandlungen*, Vol. I. Berlin, 1784, p. 83. *Effay fur les moyens de diminuer les dangers de la mer par l'affufion de l'huile, du goudron, ou de quelque autre matiere flotante, par* M. de Helyveld, Amft. 1776. Letters and Papers on Philofophical Subjects, by Franklin, p. 438. *Meifter de celebratis olei aquæ fuperfufi effectibus opticis et mechanicis*, 1778.—The laft work treats more on the teftimony of the Ancients, than on the experiments that have been made.

perfectly

perfectly consistent with the principle I have for some time been led to receive as true, that I wish for its extensive circulation.

Yours with esteem and regard,
Mr. TILLOCH. SAM. L. MITCHILL.

Copy of a Letter from Hippolyto I. Da Costa, Esq. Brasilian.

" DEAR SIR, *New-York, May* 21, 1799.

" YOUR theory, in regard to the action of *alkalis* and *calcareous earth* upon septon, or the principle of corruption, is so well proved in the several papers you have published, that it is needless to adduce further proofs to persons of knowledge: but as additional facts may be useful to persuade people of less information or more prejudices, I believe I agree with your wishes in presenting to you an account of the influence of calcareous earth upon the putrid effluvia in the city of Lisbon, which is, I think, a proof of the most interesting nature.

" The city of Lisbon is situated on the northern bank of the river Tagus, about eighteen miles from its mouth: it is about six miles in length, and its breadth is in some parts two, in some three miles, although in other parts very narrow. In the most inhabited part of the city there are seven hills or mountains, which, of course, occasion declivities and lower situations. This city may be divided into the *new* and *old* city; because there is a spot which was overthrown by the horrible earthquake of the year 1755, and was rebuilt: I call, therefore, this part the new city. The streets in this quarter are very regular, the buildings neat, and the pavements for foot passengers very commodious; but the situation is almost all very low.

" The old city, or the part which did not suffer so much in the earthquake, and preserves its ancient buildings, is in the Gothic taste, with narrow and crooked streets, in the most of which there are no pavements for foot passengers; the houses are so high, that, in some of the narrowest streets, the sun

cannot

cannot be ſeen but two or three hours every day, viz. from eleven before noon to one after noon. In the new city there are gutters or ſewers below the earth to conduct the water and impurities from the houſes and ſtreets to the river; but in the old city there are none of theſe.

"As the houſes are, in general, five or more ſtories high, and the ſtreets narrow, it is eaſy to conceive the thickneſs of population, and, of courſe, the vaſt quantity of impurity that comes into the ſtreets every day, which, with the water and other liquids poured in likewiſe, keep always there a vaſt quantity of dirt. A great ſum of money is appropriated, I know, and ſome pains taken, to preſerve the cleanlineſs of the city: but without entering into the diſcuſſion how this money is employed or diſpoſed of, which is but very little intereſting to our preſent inquiry, it is true that very often I have been obliged to make a great turn to go a ſhort diſtance, becauſe it was impoſſible to croſs the ſtreet through the dirt; and very often I have ſeen dogs, cats, and other dead animals, lie in the ſtreets.

"There is in every houſe (chiefly in the new city) a privy, with a canal which goes up to the higheſt ſtory; becauſe, as the ſeveral ſtories are inhabited by different families, they want ſuch a convenience in every one: but this canal emits always a very bad ſmell, by the accumulation of impurities within its walls, which, from the form of its conſtruction, cannot be waſhed but with water let in by a ſmall orifice or hole. There is alſo, in many houſes, a place in the inſide of the ſtreet-door for making water, which contributes its portion of bad ſmell; and the houſes are in general not very clean.

"Beſides all theſe ſources of putrid exhalations, there are a great many wharves, and much naked ſhore, which, being uncovered by the ebb-tide, preſent to the ſun a ſurface covered with dirt and ſea-weeds undergoing putrid fermentation. The mouths of the ſewers I have mentioned above go to the wharves, and are likewiſe bare at low water. The fluid

which comes from these sewers contains so many infecting matters, that its strong putrid smell can scarcely be endured.

"After this short description of the police of Lisbon, in regard to its cleanliness, every body would draw the inference, that endemical diseases must reign, not only in the summer, but in the winter time, seeing that the accumulation of the dirt in the streets is incomparably greater in the winter than in summer. The connection there is between malignant distempers and dirtiness is very well known, and expressly marked by Tissot (*Avis au Peuple sur la Santé*, chap. ii. § 7). Happily, Sir, the contrary is the fact: Lisbon is one of the most healthy situations I know, and its inhabitants do not suffer but the *common* diseases to which the human body is subjected. Many people go from England and other countries to Lisbon, in certain diseases, to enjoy the benefit of a salubrious place, and very often to spend the summer agreeably in a good and wholesome climate.

"What then can be the cause of this apparently physical contradiction between the impurity and corruption in the streets, and the salubrity of the air? I confess, Sir, I cannot find any explanation of this phenomenon if I reject the the theory of the influence of calcareous earth upon septic fluids, and I can well comprehend the reason if I admit it.

"The buildings in Lisbon are all of stone, and, in general, of marble of several qualities, and chiefly the marmor rasilis of Linnæus; and this stone is procured in the neighbourhood of the city. All the houses are white-washed inside and outside; and the handsomest new-fashioned houses are plastered with a plaster they call *escariola*, a compound of gypsum and other matters, and painted over that composition in water-colours. As a number of new buildings are continually erecting, there are, in all the streets, a great many stone-cutters hewing the stones, and their fragments are scattered through the streets. In the time of the earthquakes, as the houses fall down, the attrition of the stones, one against the other, breaks them in pieces, reducing many

to

to a powder. The pavements for the foot passengers are of large marbles; and, in many parts, the soil is calcareous too: in other parts, as the streets are paved with small round stones or pebbles, the accumulation of the calcareous powder makes a stratum above the surface of the streets and public places. When the wind blows hard, there is so great a quantity of calcareous powder flying about that it is incommodious to the eyes, and sometimes is so fine that it comes into the houses even when the windows and sashes are shut up.

" Now, to what can I impute the healthiness of that city but the quality of its calcareous earth? which neutralizes the putrid exhalations, or septic acid, which impregnates the atmosphere, and thus prevents its bad and fatal effects, preserving that city, which otherwise would be the fountain of pestilence, and the anti-chamber of death.

" As no other cause can be discovered of the healthiness of Lisbon, amongst its continual putrid infection, recourse may be had to the climate, and to the temperature of the atmosphere: but I believe it can be sufficiently proved, that the cause is the influence of the calcareous earth, and not of the climate; because, if this salubrity was owing to the climate, all the neighbourhood of Lisbon, which enjoys the same climate, would enjoy the same healthiness: but this is not the case. On the opposite bank of the Tagus, over against Lisbon, there are three or four villages, called Almada, Caparica, and Cassilhas, situated on small hills, and surrounded by beautiful farms: the buildings there are in general of siliceous stones, the soil is sandy and in some parts clayey, and the streets in these villages infinitely cleaner than in Lisbon; but intermittent and remittent fevers prevail in these villages and their neighbourhoods almost every summer, while in the mean time Lisbon is perfectly free. Near the other part of the river, in the neighbourhood of Lisbon, on the shore of the ocean, there are other small villages, as Cintra and Collares, from whose neighbourhoods the stone

of

of the Lifbon buildings comes, and the foil is in a great part calcareous. Thefe places are pointed out as the feat of health, and, indeed, are the moft beautiful and pleafant fummer retreats you can imagine.

"After this ftatement, can any body attribute the falubrity of Lifbon to its climate merely? Certainly not: becaufe I obferve, that where there is calcareous earth there is no infection, notwithftanding the continual exiftence of putrid exhalations; and where there is not calcareous earth, and the foil is fandy, gravelly, and clayey, there are fevers, although the climate is the fame; the diftance of thefe places being only the breadth of the river, about three miles.

"To thefe unanfwerable facts I muft add, that I have obferved, two or three times, in Lifbon, dead animals upon the ruins of houfes, and of courfe furrounded with calcareous earth, in a ftate of deficcation; and, at the fame time, two or three fathoms diftant, another animal dead too, and lying upon another kind of foil, in a ftate of complete putrefaction. The reafon of their prefervation is obvious: the feptic acid was abforbed by the calcareous earth as foon as it was formed by the union of fepton with oxygene; likewife, the oil formed by the union of their hydrogene with carbone has been imbibed, the water formed by the junction with oxygene evaporated, and the remaining parts of the animal were left in a dry ftate.

"The effects of calcareous earth and alkalis feem to be very well underftood by the people of Portugal: they put chalk and plafter with the bodies they bury in the churches; and they wafh with plafter the rooms where there have been any fick or contagious diforders. This precaution they never omit.—I pray you to accept my beft wifhes.

"I am, dear Sir,

"Your's, very fincerely and affectionately,

"HIPPOLYTO I. DA COSTA.

"Samuel L. Mitchill, Efq."

III. *An Account of Mr.* Brown's *Travels through Egypt and Syria,* &c.*

Mr. BROWN arrived in Egypt on the 10th of January 1792, after a paffage of twenty-fix days. Some information which he obtained in Alexandria having induced him to attempt exploring the veftiges of the temple of Jupiter Ammon, he procured an interpreter, and made the neceffary arrangements for the conveyance of his baggage and provifions, with fome Arabs, who are employed in tranfporting through the defert dates and other articles between Siwa and Alexandria. In this bufinefs he was much affifted by Mr. Baldwin, who readily entered into his views, and did every thing in his power to promote their fuccefs.

On the 24th of February Mr. Brown, accompanied by the Arabs, left Alexandria, and travelled the firft day only about eight miles. From that period till the 4th of March their route lay along the coaft, and they were never long out of fight of the fea. The foil was generally fmooth and fandy, and the vegetation was very inconfiderable; the greater part confifting of different kinds of glafs-wort or *kali*, which, however, afforded a feafonable relief to the fuffering camel. For their horfes they were obliged to carry a conftant fupply of barley and chopped ftraw. There are feveral kinds of preferved meat prepared among the orientals for long journies. They obviate the inconveniency of falt provifion by ufing clarified butter. The kind moft ufed is called *mifhli*, and will keep good for many years. It is brought from weftern Barbary to Kahira (Cairo).

On Sunday the 4th, having travelled about fix hours, they arrived at a well where they found a copious fupply of water; and, having refrefhed their camels, they left the coaft, and proceeded in a fouth-weft direction. From Alexandria to this well the time employed was about feventy-

* Extracted from the Account of his Travels juft publifhed.

five

five hours and a half. As they had little hope of finding any more water between that and Siwa, they were obliged to uſe all poſſible diligence on the route, ſo that they arrived there on Friday the 9th at eight in the evening.

Siwa, which anſwers the deſcription given of the Oazes, is a ſmall ſpot ſurrounded on all ſides by deſert land. It was about half an hour from the time of their entrance on this territory, by a path bordered with date-trees, that they arrived at the town which gives name to the diſtrict. They diſmounted, and ſeated themſelves, as is uſual for ſtrangers in that country, on a *misjed*, or place employed for prayer, adjoining to the tomb of a *Marabût*, or holy perſon. In a ſhort time the chiefs came to congratulate them on their arrival, after which they conducted them to an apartment, not indeed very commodious, but the beſt they were provided with; and, after a ſhort interval, a large diſh of rice and ſome boiled meat were brought in, the ſchechs attending while the company was ſerved, which conſiſted of Mr. Brown's interpreter, his conductor, two other Bedouins, their companions, and himſelf.

It being diſcovered that Mr. Brown, though in the Turkiſh dreſs, was a Chriſtian, he experienced ſome bad treatment from the populace, and was obliged to confine himſelf to his apartment for two or three days. On the fourth, however, he was allowed to walk abroad and to obſerve what was remarkable in the place. Having walked about two miles he arrived at what they called the Ruins, or *Birbé*; and was ſurpriſed at finding himſelf near a building of undoubted antiquity, and, though ſmall, in every view worthy of notice. It was a ſingle apartment built of maſſy ſtone of the ſame kind as thoſe of which the pyramids conſiſt, and covered originally with ſix large and ſolid blocks that reach from one wall to the other. The length he found thirty-two feet in the clear, the height about eighteen, the width fifteen. A gate, ſituated at one extremity, forms the principal entrance; and two doors alſo, near that extremity, open

open oppofite to each other. The other end is quite ruinous; but, judging from circumftances, it may be imagined that the building has never been much larger than it now is. There is no appearance of any other edifice having been attached to it; and the lefs fo, as there are remains of fculpture on the exterior walls. In the interior, there are three rows of emblematical figures, apparently defigned to reprefent a proceffion; and the fpace between them is filled with hieroglyphic characters properly fo called. The *foffit* is alfo adorned in the fame manner, but one of the ftones which formed it is fallen within: the other five remain entire. The fculpture is fufficiently diftinguifhable; and even the colours in fome places remain. It was mentioned to Mr. Brown, that there were many other ruins near; but after walking for fome time where they were defcribed to be, and obferving that rough ftones, apparently detached from the rock, were pointed out to him as ruins, he returned fatigued and diffatisfied. The fchechs had prepared for them a dinner in a garden, where they were unmolefted by intruders; and the fun being then near the meridian, Mr. Brown took the opportunity of obferving its altitude by means of an artificial horizon. The refult was not materially different, though in the fequel he repeated his obfervation: it gave N. L. 29° 12′ and a fraction; the lon. E. F. 44° 54′.

Mr. Brown having found a monument fo evidently Egyptian in this remote quarter, entertained greater hope of meeting with fomething more confiderable by going farther, or of being able to gain fome information from the natives, or the Arabs, that would fix exactly the pofition of the remains, if any fuch there were, of the far-famed temple of Jupiter Ammon. He therefore applied to three of the fchechs who had fhewn themfelves moft friendly towards him and his attendants, and having enquired whether they knew of any ruins farther to the weftward or fouth-weft, one of them replied that there was a place (*Arafchie*) where there were ruins, but that it was impoffible to approach it, as it was

furrounded by water, and there were no boats. Mr. Brown foon found, from the defcription, that *Arafchié* was not the Oafis of Ammon; but, conceiving it fomething gained to pafs farther weft, he determined to proceed thither. For this purpofe it was neceffary to ufe all poffible fecrecy, as the Siwefe were bent on oppofing his farther progrefs. An agreement was therefore made with two perfons of the poorer clafs of the natives, for a few zechins, that they fhould conduct him and his attendants to *Arafchié*, and that, if what they fought for was not there, they fhould proceed with them to the firft watering place that they knew of directly to the fouthward. The remainder of the time he ftayed at Siwa was employed in combating the difficulties raifed about his departure; and it was not till Monday, the 12th of March, that he was enabled to commence his journey weft.

The Oafis, which contains the town of Siwa, is about fix miles long, and four and a half or five wide. A large proportion of this fpace is filled with date-trees; but there are alfo pomegranates, figs and olives, apricots and plantains; and the gardens are remarkably flourifhing. The inhabitants cultivate a confiderable quantity of rice, which, however, is of a reddifh hue, and different from that of the Delta. The remainder of the cultivable land furnifhes wheat enough for the confumption of the inhabitants. Water, both falt and frefh, abounds; but the fprings which furnifh the latter are moft of them tepid; and fuch is the nature of the water, air, and other circumftances, that ftrangers are often affected with agues and malignant fevers. One of thofe fprings, which rifes near the building before defcribed, is obferved by the natives to be fometimes cold and fometimes warm. After the rains the ground in the neighbourhood of Siwa is covered with falt for many weeks.

Mr. Brown, having left his temporary refidence, proceeded, himfelf and interpreter on horfeback, his original conductor on foot, and the two men he had hired each on an afs; but he had not gone far before one of the latter told him that it

would

would be neceſſary to return, as the people of the town were in purſuit of them, and would not permit them to go and diſinter the treaſures of *Araſchié*. They nevertheleſs continued their journey for two days, and at the end of that time arrived at the place deſcribed to them. It was not far from the plain of *Gegabib*. Mr. Brown here found an iſland in the middle of a ſmall lake of ſalt water, which contained miſ-ſhapen rocks in abundance, but nothing that he could poſitively decide to be ruins; nor was it very likely that any ſuch ſhould be found there, the ſpot being entirely deſtitute of trees and freſh water. Mr. Brown, however, had the curioſity to approach nearer to theſe imaginary ruins, and accordingly forced his horſe into the lake. The horſe, from fatigue and weakneſs, or original inability to ſwim, ſoon found himſelf entangled, and could not keep his head above water. Mr. Brown fell with him, and was unable to detach himſelf; and when he at length found himſelf on dry ground, the circumſtances he was under prevented him from making any farther obſervation on this iſland and lake.

After viſiting this place, Mr. Brown and his attendants continued their journey ſouth according to the agreement made with the guides, but found the purſuit equally fruitleſs. At the end of the third day, having arrived in lat. 28° 40′, or nearly ſo, they became much diſtreſſed for water: they remained a whole night in ſuſpenſe concerning their deſtiny, when at length a ſupply of that neceſſary refreſhment was found. As they did not, however, diſcover any thing that bore the leaſt reſemblance to the object of their ſearch, they were obliged to think of returning, which they did; and, falling into the ſtraight road from Siwa to Alexandria, arrived at the latter on the 2d of April 1792 *.

Mr. Brown, after remaining ſome time at Alexandria, to

* Mr. Brown ſays, that an opinion has been communicated to him, that Siwa is the *Siropum* of Ptolemy, and that the building deſcribed was probably coeval with the temple of Jupiter Ammon, and a dependency on it. D'Anville ſuppoſes Siwa to be Mareotis.

recover from the effects of his journey, commenced, on the 1ſt of May, another to Raſhid, where he ſtaid five days; and on the 6th of May embarked with a view of proceeding to Terané, a town ſituated on the left of the moſt weſtern mouth of the Nile, at a very ſmall diſtance from the river. From Terané Mr. Brown made an excurſion to view the lakes which produce natron, and to obſerve that production in its naſcent ſtate. One of them was very irregular in its form, ſo that it was not eaſy to ſay what might be the quantity of ground covered with water. It is higher in winter than in ſummer; and, at the period when Mr. Brown viewed it, he could no where diſcover that the breadth of it exceeded a mile: its length might be nearly four. Towards the end of ſummer theſe lakes, it is ſaid, are almoſt dry, and the ſpace from which the water has retired is then occupied by a thick depoſition of ſalt. Not far from the eaſtern extremity a ſpring riſes with ſome force, which much agitates the reſt of the water. Cloſe to the ſpring the depth was far greater than our traveller's height, in other parts it did not generally exceed three feet. The thermometer near the ſpring ſtood at 76, while in the open air it was at 87. The more weſtern lake differs not materially from the eaſtern, in ſize, form, or productions: the colour of the water in both is an imperfect red, and, where the bottom is viſible, it appears almoſt as if covered with blood. Salt, to the thickneſs of five or ſix inches, lies conſtantly in the more ſhallow part. How thick the ſubſtance of natron commonly is in the lake, Mr. Brown did not accurately determine; but thoſe employed to collect it, reported, that it never exceeded a cubit or common pike. Having ſpent two days and part of a third in the vicinity of the lakes, Mr. Brown's attendants grew tired, and he was obliged to return. After a ſhort interval he embarked for Kahira, and arrived there on the 16th of May 1792.

Mr. Brown being determined to undertake a journey to Abyſſinia, employed the greater part of the ſummer, which he

he ſpent at Kahira, in learning the Arabic language; but ſtill judging that he ſhould have occaſion for an interpreter, he took care to provide a Greek, who, beſides his native language, was acquainted with the Turkiſh, Arabic, and Italian: he had alſo with him a Mahommedan of the lower claſs of the Kahirines, who, as belongs to that character, was prepared for every office. Thus provided, he ſet out by water on the 10th of September, and on the 8th day reached Aſſiut. Having ſpent about fourteen days here waiting for a boat, he was at length able to hire one of a moderate ſize; and leaving Aſſiut on the 4th of October, arrived on the 11th at Girgi, formerly the capital of Upper Egypt. On the 17th he arrived at Dendera, the ancient Tentyra, where he ſaw the noted temple, the moſt perfect ſpecimen of Egyptian architecture now remaining. It is in the form of an oblong ſquare, 200 feet by 150, Pococke ſays 145, and is now almoſt buried in the ſand. The ſame night, about twelve, he reached Ghenné, the ancient Cœne or Cœnopolis; and on the 23d came to Akſòr, the ancient Thebes. After paſſing three days in and around theſe ruins, Mr. Brown proceeded on his voyage up the Nile, and on the 31ſt arrived at Aſſûan, the ancient Syene, where he remained three days, contriving, if poſſible, to purſue his route up the river; but a war having ariſen between the Mamlûks of Upper Egypt and the Caſhef of Ibrim, no one was ſuffered to paſs from Egypt to Nubia. The caravans had all been ſtopped for many months, and not even a camel could be procured. Our traveller being therefore conſtrained, with deep regret, to abandon his deſign of penetrating to Abyſſinia by this route, gave up all hope for that ſeaſon, and began to think of returning.

Mr. Brown, therefore, left Aſſûan on the 4th of November 1792, and, proceeding rapidly down the Nile, arrived at Ghenné on the 7th. From Ghenné he made a ſhort excurſion to Coſſir; but he did not think it adviſeable to ſtay long there, as the people were highly incenſed at that time

 againſt

againſt the Franks on account of the following circumſtance, which had taken place there three or four years before. An Engliſh veſſel, commanded, as is ſaid, by a Captain Mitchel, having moored there, a quarrel aroſe between the crew and the natives reſpecting a ſupply of water, which is a commodity difficult to be procured. From a violent contention blows enſued, and the captain thought himſelf juſtified to fire upon the town; in conſequence of which ſeveral perſons, ſome ſay fourteen, were killed, and much damage done. The natives were exceedingly exaſperated, and ſwore to ſacriſice the firſt Engliſhman that ſhould fall into their hands. Mr. Brown found little to reward him for expoſing himſelf to the danger of this excurſion, except the ſight of ſome curious rocks, which he thus deſcribes:—The roads we travelled in going to Coſſir, as well as in returning, have ſomething in them very remarkable: the rough and lofty rocks of granite and porphyry, with which it is on all ſides environed, have a magnificent and terrific appearance; and the road between them, which is almoſt level throughout, gives the idea of immenſe labour in cutting it. All theſe circumſtances concur in teſtifying the importance Coſſir muſt once have had as a port. In the route we took in going, at certain diſtances, on the higheſt rocks, is obſervable a ſucceſſion of ſmall ſtructures, formed with uncemented ſtones, and which, by the marks of fire within them, ſeem to have ſerved as ſignals. Theſe are numerous, but they are too rude to enable one to fix any time for their erection. They appear to me to be pretty ancient. The red granite is in vaſt quantities; and the chain of rocks, conſiſting of that ſubſtance, appears to extend itſelf in a north and ſouth direction. Huge rocks of porphyry, both red and green, are diſtinguiſhable; and, as appears, more of it in the road we purſued in going than in that by which we returned. I obſerved ruins of alabaſter in both, but particularly in returning. The *verde antico*, it was long before I could diſcover; at length I found it in returning, by the ſigns Bruce had deſcribed. In ſhort, the

the route unfolds a treaſure of marbles that aſtoniſhes the beholder, and demonſtrates, that, on any future occaſion, the quarries may be again wrought, and modern architecture equal that of the beſt ages of Greece or Rome as to richneſs and durability of ornament, if ever it ſhall in juſtneſs of proportion, ſimplicity of taſte, or unity of parts in one ſublime whole, which, indeed, ſeems ſufficiently problematical. On the 21ſt of November Mr. Brown returned to Aſſiut, and on the 30th ſet ſail for Kahira, which he reached on the 8th of December.

[To be continued.]

IV. *Means propoſed for ſaving the Crews of Veſſels ſhipwrecked near the Coaſt. By an anonymous Author*.*

EIGHT or nine years ago, being much ſtruck by an account which I read of the ſhipwreck of twenty-four perſons who periſhed ſo near the ſhore that their cries could be diſtinctly heard, an idea immediately occurred to me, of endeavouring to diſcover ſome means proper for ſaving the crews of ſhipwrecked veſſels, at leaſt under ſuch circumſtances, that is to ſay, at the diſtance of forty or fifty fathoms from the ſhore; for I did not then imagine that it could be done at the diſtance of two or three hundred, as I afterwards diſcovered. I perceived at firſt that the only means to ſave the crew of a veſſel in ſuch a ſtate, would be to eſtabliſh a rope of communication from the ſhore to the ſhip. After examining a number of means, both ancient and modern, I fixed on a bomb or cannon-ball (a bomb I think preferable), to which ſhould be faſtened the end of the rope, extended afterwards in a zig-zag direction before the mortar or cannon, or ſuſpended on a piece of wood raiſed ſeveral feet. But as it was neceſſary to know if the cord would not break by the

* From a late French Journal.

force of the explosion and the velocity of the motion, I thought it proper to consult professional men. I wrote to some officers of the artillery in garrison at La Fere, and they almost all replied that the rope would infallibly break.

Not satisfied with this answer, I happily conceived the idea of making the experiments on a small scale. I caused a piece of the barrel of a musket to be filed into the form of a small mortar of 18 lines in length internally; and having tied a packthread to a common ball of lead, I made an experiment, which perfectly succeeded, as did a great many others which I repeated afterwards even with the strongest charges of powder. I communicated this success to these officers of artillery, who replied, that there was a great difference between a quarter of an ounce of powder and four or five pounds employed for a bomb; and, in short, that the rope would break.

Being desirous to ascertain what truth there might be in this assertion, I repaired to a large iron furnace, where I remained ten days, and where I caused a mould to be formed for a four-inch mortar and a bullet of the same calibre: I had them both cast, and made an experiment with a rope three or four lines in diameter and eighteen ounces of powder, which succeeded. I then came to Paris, where, after staying eight months, I obtained an order from government to make my experiments on a grand scale even at La Fere, where I had to expect men prejudiced against the success of my attempts. When I went thither they persisted that they would not succeed. I knew, however, what I had to depend upon, as I had already made experiments. In short I repeated them, and they completely succeeded. The first day, nothing being done in a proper manner, some of the experiments failed; but things being arranged better next morning, we repeated them seven times without once failing, viz. four times with a mortar of eight inches, and three with one of twelve, augmenting each time the charge of the

the powder from the weakeſt to the ſtrongeſt. The ſpectators having judged that this number was fully ſufficient to eſtabliſh the truth of the diſcovery, no more were made.

I ſhall now proceed to other means, which I have deviſed not only for ſaving the crews of veſſels, but alſo the greater part of the cargoes when expoſed to danger near the coaſt.

1ſt, It muſt be remembered, that, in ſuch circumſtances, the only thing neceſſary is to get a cord of communication conveyed to the veſſel in danger. It ought to be remembered alſo, that a veſſel is never caſt away or periſhes on the coaſt, but becauſe it is driven thither againſt the will of the captain, and by the violence of the waves and the wind, which almoſt always blows from the ſea towards the ſhore, without which there would be no danger to be apprehended: conſequently, in theſe circumſtances, the wind comes always from the ſea, either directly or obliquely, and blows towards the ſhore.

A common paper kite, therefore, launched from the veſſel and driven by the wind to the ſhore, would be ſufficient to ſave a crew conſiſting of 1500 ſeamen, if ſuch were the number of a ſhip of war. This kite would convey to the ſhore a ſtrong packthread, to the end of which might be affixed a cord, to be drawn on board by means of the ſtring of the kite; and with this cord a rope, or as many as ſhould be neceſſary, might be conveyed to the ſhip.—It may be readily conceived that I cannot here enter into any detail concerning various circumſtances relating to this ſubject which it might be neceſſary to mention.

2d, A ſmall balloon, of ſix or ſeven feet in diameter, and raiſed by rarified air, would be alſo an excellent means for the like purpoſe: being driven by the wind from the veſſel to the ſhore, it would carry thither a ſtring capable of drawing a cord with which ſeveral ropes might be afterwards conveyed to the veſſel. Had not the diſcovery of citizen Montgolfier produced any other benefit, it would be entitled on this account to be conſidered as of great importance.

3d, A

3d, A ſky-rocket, of a large diameter, would be of equal ſervice. It would alſo carry, from the veſſel to the ſhore, a ſtring capable of drawing a rope after it. C. Ruggieri, whom I have conſulted on this ſubject, told me, that he made ſome four inches in diameter, which roſe to a great height; and that, with a ſtring attached to them, they would go to the diſtance of four or five hundred fathoms, which is more than would be neceſſary. They may be kept in a ſtate fit for ſervice two years, if depoſited in a dry place.

Laſtly, A fourth plan for ſaving the crew of a ſhipwrecked veſſel, is that of throwing from the veſſel into the ſea an empty caſk with a cord attached to it. The wind and the waves would drive the caſk to the ſhore, and afford the means of eſtabliſhing that rope of communication already mentioned. Each of theſe methods may be improved, but I cannot at preſent enter into any detail *.

V. *On the different Kinds of Cadmia, and particularly thoſe of Zinc and Cobalt. By* I. I. Bindheim *of Moſcow* †.

THE ſureſt method of claſſing minerals is without doubt to arrange them, not according to their external characters, but according to their internal component parts. For, though the former in ſome meaſure ſerve for diſcrimination, and are therefore not altogether uſeleſs, they are not ſo preciſe and certain as to form a baſis for a ſyſtem of mineralogy,

* The author of the above papers ſays, that he announced his diſcovery in the *Affiches de Paris* on the 29th of January 1794. However this may be, we know that one of his methods, that of conveying a rope to the ſhore, by attaching it to a bullet or bomb to be afterwards fired from a cannon or mortar, was propoſed a few years ago by a ſerjeant or officer of artillery at Woolwich, named Bell. Some experiments of the ſame kind made at Portſmouth, we believe, anſwered expectation. The uſe of a kite or rocket ſeems to deſerve attention; and we do not heſitate to ſay, that the former could hardly fail of producing the deſired effect. At any rate it might be eaſily tried. Editor.

† From *Neue Nordiſche Beyträge*, by Profeſſor Pallas, Vol. VI.

ſince

ſince the attentive naturaliſt is ſufficiently taught, by experience, that in the mineral kingdom ſubſtances of the ſame genus, though different in external form, conſiſt often of the ſame component parts; and that other bodies of the like kind differ in their component parts, though perfectly alike in their external appearance. As this is the caſe, we can find no better guide to conduct us to an invariable claſſification, arrangement, and definition of mineral bodies than chemiſtry; a knowledge which muſt be united with that of the external characters of minerals.

To give an inſtance of the uncertainty which ariſes when theſe are ſeparated, I ſhall here mention thoſe ores which are known by the name of *cadmia*; for it would ſeem, by the many improper denominations which are often founded on their external characters, as if we were almoſt conducted back to the dark age of Cadmus, from whom the Europeans are ſaid to have firſt learnt the art of fuſing ores on a large ſcale, and from whom, in all probability, the term *cadmia* had its origin. In this reſpect chemical knowledge is a better guide than external characters, and the names thence deduced, and often very improperly; it enables us to define minerals with more accuracy, and conducts us nearer than the latter to the real knowledge of nature in this department, without which all mineralogical knowledge muſt be uncertain and imperfect. As it would be ſuperfluous to ſay more on this ſubject, I ſhall, for the preſent, confine myſelf to the cadmias, and thoſe ores alone which, when decompoſed in a proper manner, and fully purified, yield thoſe metals called zinc and cobalt.

Of Zinc.

Ores that contain zinc are found in numerous varieties and of different forms. Sometimes they are combined with oxygen and the ſulphuric acid; and ſometimes there are found in them, beſides zinc, various foreign component parts, ſuch as argil and ſiliceous earth, a little iron, lead,

and,

and, at times, alſo a ſmall portion of copper. In blende the ſulphur is combined with iron, and the particles of zinc are ſcattered through the mixture. The ſo called furnace calamine is obtained by the fuſion of ſome kinds of lead ore when the particles of zinc are ſublimated by ſtrong heat to a cooler place of the furnace called the *zinc ſtool*, where they adhere in the form of a grey or yellowiſh ſtone. In preparing braſs, and other operations of the like kind, the ſublimated zinc calx is collected under the name of *white nicht*; but what adheres lower down, and becomes a hard maſs, is called *grey tutia*; and this ſubſtance, as ſome ſulphureous vapour ſeems to adhere to it the longer it lies expoſed near the ſmelting houſes, becomes, by the effects of the atmoſphere, always more proper for uſe. Beſides the above, we have zinc calx, zinc ſpar, tutanego ore, the laſt of which was firſt diſcovered in China; but I am convinced, by experiments, that a like ore, which is natural flowers of zinc, is found in Germany in the Thomas-ſtollen at Bleiberg. We have alſo zeolite-formed calamine, zinc blende, glittering blende, black blende, reddiſh brown, phoſphoriſed, greeniſh-yellow, white, and yellow blende. Such kinds are found in England, Siberia, China, Sweden, Sileſia, Saxony, &c.

In examining theſe ſubſtances various chemiſts have rendered great ſervice to mineralogy, particularly Brand and Schwab, counſellors of the mines in Sweden; and theſe were followed by Juſti, Pott, Henkel, and, above all, Margraaf, who employed great care and accuracy in fuſing and examining them; but Bergmann, to whom ſcience is ſo much indebted, has given moſt excellent models for the decompoſition of theſe ores. Whether there be native zinc or not, has never yet been fully aſcertained; and we muſt ſtill remain in doubt until the account of its being found in the iſland of Naxos, in the Archipelago, be better confirmed. The zinc ore of Goſlar, that found in Cornwall, and a little of the Swediſh, can be rendered uſeful and pro-

 ductive.

ductive. The zinc obtained from China, under the name of *tutanego*, is conſidered to be purer than the German, and therefore a ſmall difference is obſerved in their ſpecific gravities.

The properties of zinc ſeparated from its ore, and purified, are, that it ſcarcely undergoes any variation in atmoſpheric air or in water; and that, by the addition of copper, in different proportions, you obtain braſs, pinchbeck, prince's metal, Manheim gold, &c. All acids deprive it of its inflammable matter, and diſſolve it with efferveſcence. With the vitriolic acid it gives a cryſtalline ſalt, which is ſulphat of zinc, or, as it is commonly called, white vitriol. That white vitriol which is obtained not in a cryſtalline form, but in white maſſes like refined ſugar, contains often a mixture of foreign metallic particles, ſuch as iron, copper, and lead; but it may be purified by adding to a ſolution of it pure zinc, by which the above metals will be precipitated: if the ſolution be then filtered, and expoſed to cryſtalliſe, you will obtain pure white vitriol.

By the nitrous acid, zinc is diſſolved with a ſtrong efferveſcence and in great quantity producing cryſtals: if you pour alcohol over theſe and diſtil them, you will obtain very good edulcorated ſpirit of nitre. It diſſolves alſo in the muriatic acid, and emits a ſtrong offenſive vapour; this clear ſolution ſaturated cannot be brought to ſhoot into cryſtals: if you reduce it by evaporation to a gelatinous maſs, and place it in a retort over the fire, you obtain, in the ſame manner as when you diſtil zinc with ſal-ammoniac and corroſive ſublimate, butter of zinc of a ſomewhat thick conſiſtence.

It is ſoluble alſo in aqua-regia, and by that acid gives a triple neutral ſalt, in the ſame manner as ſal-ammoniac. It diſſolves likewiſe in concentrated acetous acid, and ſhoots into cryſtals: the remaining acids, viz. of ſparry fluor, arſenic, borax, ſugar, tartar, ſorrel, citrons, ants, phoſphorus, and fat, exerciſe an action over zinc alſo. The alcaline ſolvents do the ſame; and the proceſs ſucceeds beſt with a concentrated

trated folution of the volatile, not cauftic alcali, during which an effervefcence is obferved, and by which the zinc exhibits traces of an acid: the produce is cryftals of a neutral falt.

Flowers of zinc, like zinc itfelf, are foluble in an acid; but with this difference, that no effervefcence takes place. Thefe flowers are produced during the fufion of zinc in an open crucible, when the heat is increafed to above 370 degrees. The metal then inflames with a whitifh-green flame of a dazzling brightnefs, which feems to diffufe over the faces of thofe prefent a death-like palenefs; and the metal, by being deprived of its inflammable matter, (united to oxygen,) is converted into a tender calx, which, by the violence of the inflammation, is, on account of its lightnefs, carried upwards like wool or a cobweb. Zinc, calcined in this manner, is called the flowers of zinc, and alfo *philofophic wool*, not to mention other fingular appellations of the alchemifts. During this operation zinc exhibits fome phenomena, fuch as the fmell, the flame, &c. which are fimilar to thofe that occur during the combuftion of phofphorus; and therefore people were led to fuppofe that the phofphoric acid was contained in zinc. By the above procefs the weight of this calx is increafed a tenth part, and, as fome have remarked, even more, and at the fame time it becomes fixed. When expofed on coals to the blow-pipe, it becomes yellow, and on cooling refumes its whitenefs, which is a proof that the flowers of zinc are genuine. It can be fufed into a yellowifh-brown glafs, and, by adding the inflammable matter, can be reduced in clofe veffels.

In a clofe veffel, expofed to a violent heat, zinc goes over in a metallic form, and by thefe means acquires the property of creaking, when it breaks like tin. It can alfo be brought to fuch a ftate that it may be drawn out into thin plates, and be flatted between metal cylinders; fome fpecimens of which, by M. Sage of Paris, and M. Kratz of Berlin, I have in my poffeffion. Zinc may be combined with the

5 greater

greater part of metals, but not with lead, iron, or bismuth; and it may be amalgamated with quicksilver. This amalgam of zinc is very proper for strengthening the power of an electric machine, and Higgins has given a prescription for preparing it. In the dry way it has the greatest affinity with copper, and produces with it a more or less yellow composition, which can be obtained by no other metal. In this respect, then, it is essentially different from all other metals, and becomes itself a very useful one, as it is used for brass, pinchbeck, prince's metal, bronze, Manheim gold, and in fire-works, &c.

It is very remarkable, in regard to zinc, that neither sulphur nor liver of sulphur * produces on it any effect; whereas gold, which sulphur cannot overcome, is dissolved by liver of sulphur.

On this occasion I cannot omit making mention of the celebrated alkahest of Respur, who believed, that when he alcalised zinc and rendered it caustic, and had obtained from it a purple-coloured mass, volatile in the open air, he had found out a menstruum, by which he could radically dissolve all metals. A paradoxical position, which was long adopted by the gold-making alchemists, but which has never been realised.

[To be concluded in next Number.]

VI. *Description of an Assay-furnace, with an Apparatus for measuring the Degree of Heat employed. By Mr.* David Mushet *of the Clyde Iron Works. Communicated by the Author.*

In my last paper I mentioned, that, in order to facilitate the operations of the assay-furnace, and to compare the various degrees of heat in which different experiments are

* It has been ascertained that zinc and sulphur can be united; but the process is difficult, on account of the easy oxidation and volatility of the zinc. See *Mem. de Dijon*, 1783.

effected,

effected, I had constructed the pyrometer which I am now about to describe. It can in no point of view be considered as an universal instrument, as its scale will be entirely local, and vary according to the construction and exigencies of the furnace: it possesses, however, this advantage, that after a scale of comparison is formed betwixt it and Wedgewood's, in the manner described in the explanation, the assayer can at any time mark, with considerable accuracy, the degree at which an experiment is effected, and compare it with the degrees of that scale; and if the furnace and apparatus are kept in proper repair, the results will be consistent with former ones.

Description *of the* Furnace.

A A (Plate V.) the pedestal of brick-work on which the furnace is reared. B, the ash-pit. C, a view of the central parts of the grate, with a knee two inches deep and four inches square, for the purpose of receiving a pedestal of fire-clay for supporting the crucible. DD, the section of an iron cylinder, which contains the brick-work, with flanges projecting inwards both at top and bottom: the upper flange contains two grooves for sliding the cover I, (made of cast iron;) and the under one projects so far as to form a support for the bars of the grate. E E, the lining of the furnace, composed of fire bricks. F, the fire-place, three feet deep, ten inches diameter at the grate, and diminishing to nine inches at the top. G, the flue or draught-hole, which communicates with the chimney. H, the chimney (the top broken off to make it come into the plate), which should never be less than 30 feet high, and nine inches square in the passage. K, an oblong rectangular plate, which projects from the top of the cylinder for the purpose of supporting the pyrometer. L L, an iron box with a square bar of steel, which, in expanding, acts upon the lever at the distance of one inch from the fulcrum.

The letters of the horizontal and vertical section refer to the same parts of the furnace.

Descrip-

Description *of the* Pyrometer.

The principle upon which this instrument is constructed is the expansion of metal by heat. After several experiments with copper, iron, and steel, I was induced to give the preference to the latter. Copper was found to be too easily fused, and the scale by that means less extensive than was wished. Malleable iron, by being heated in this manner, frequently acquired permanent additional length, and passed into the state of semi-steel. This principle it derived from the contact of the surrounding charcoal, introduced for the purpose of preventing oxydation from taking place upon the surface of the bar. Highly cemented steel, when exposed in this manner to the greatest heat, acquired no sensible increase of length: a bar of polished steel was therefore adopted.

A corresponds with the plate of iron K in the drawing of the furnace, on which the pyrometer is supported. B an upright, on which is suspended the lever. CC the lever, ten inches long from the fulcrum to the extremity, which acts upon the scale, and one inch on the other end from the same point to a line drawn through the centre of the expanding bar. From this it is obvious, that if the short end of the lever be elevated half an inch by the expansion of the bar of steel, the other end will suffer a depression ten times as much, or equal to five inches. These I have divided into 50 degrees, (equal to each other on a tangent of the arch that forms the scale DD,) so that the most minute expansion in the bar will be visibly indicated. Should the ratio of ten to one be thought too small, the power of the lever can easily be increased to 13 or 20, and the scale thus greatly enlarged. When the pyrometer is at rest, the index points at 0°, and its other extremity rests lightly upon the sharp point of the steel bar. It is therefore requisite to make the lever nearly an exact balance, by forming its short end sufficiently weighty to overcome the great length of the other. The scale being carried the length of 50 degrees, allows the bar to expand

5-10ths. This, however, will not be the case, though exposed to a degree of heat approaching to fusion. EE are two supports for the scale, attached to the extremity of the plate by means of bolts. FF is a box of wrought iron which contains the bar of steel exactly fitted, with a small allowance for expanding in the thickness. This box is introduced into the lining of the furnace by means of square notches formed in the bricks about two inches from the contact of the fire. The bottom of the box rests upon the under-flange of the cylinder, and its other end rises through the building and iron-cover about two inches. When at first introduced into its place, the space which may remain betwixt the outside of the box and the building is carefully filled with fine charcoal dust, to prevent oxydation by the chance contact of atmospheric air. G is a polished bar of steel 3 feet 2 3-4th inches long and 1-4th of an inch square, the sharp extremity of which acts upon that part of the lever which, when at 0°, measures one inch from the fulcrum. HH, a small box or cover, which fits upon the top of the iron box by means of pins. This is always kept full of charcoal-dust, to prevent the approach of external air, and the transmission of heat from within.

This instrument may be used in conjunction with Mr. Wedgewood's scale. Any given substance may be melted, and the degree marked upon the scale: let this be compared with the degree of heat at which the same substance melts by Wedgewood's scale; then let the greatest degree of heat of the furnace be measured by one of Wedgewood's rolls, and compared with that pointed out by the index, the one difference divided by the other will give a scale of comparison.

It will hardly escape the notice of men of science, that circumstances may be so varied, by the modes of charging the furnace, as to endanger an erroneous result: but, if proper attention be paid, the assayer will soon understand the trim of his furnace so thoroughly as to be sure of always obtaining such an accurate indication of the heat as cannot

fail to be of effential fervice to him. This fact I can atteft from experience.

If abfolute precifion be wanted, it may be obtained by employing three or more pyrometers, diftributed at regular diftances round the furnace, inftead of ufing only one. The mean of the whole will be the true degree of heat in the furnace.

VII. *Agenda, or a Collection of Obfervations and Refearches the Refults of which may ferve as the Foundation for a Theory of the Earth.* By M. De Saussure.

[Continued from page 190.]

CHAP. XVIII.

A. *Obfervations to be made on Volcanoes at the Time of an Eruption.*

1. THE form, dimenfions, and elevation of the crater.

2. The colour, elevation, and other fenfible qualities of the flames and the fmoke.

3. Phenomena which preceded the eruption, fubterranean noife, earthquakes, extraordinary movements of the fea.

4. Phenomena which accompany the eruption; as thunder, lightning, pofitive or negative electricity, fubterranean noife, earthquakes: fcoriæ, afhes, and ftones thrown up; to what height and diftance.

5. Smell of the fmoke. In general it indicates the fulphureous acid; but it may indicate alfo bitumen and coal.

6. Nature of the gafes which efcape during the eruption.

7. Velocity of the lava. Its degree of fluidity compared with the inclination of the ground over which it flows.

8. To meafure, if poffible, the degree of its heat when it iffues from the volcano.

9. Whether the lava appears to be in a ftate of combuftion, or only incandefcence.

 10. Whe-

10. Whether it does not cool more ſlowly, and according to other laws, than that of the bodies heated or melted in our furnaces.

10. A. Can it be ſuppoſed that the matter thrown up by volcanoes was not inflamed, or even in a ſtate of incandeſcence, in the bowels of the earth; and that it is only the contact of the air which gives it theſe qualities?

11. Whether the ſudden cooling of lava in the air or in water divides it into priſmatic columns, ſuch as thoſe of baſaltes.

12. Whether it be true that ſcoria newly thrown up, and ſuddenly cooled by its rapid paſſage through the air, ſeems covered with a bitúminous varniſh.

13. And, in general, whether the mountain throws up bituminous matter or any thing that reſembles the reſiduum of the combuſtion of coal, or whether it rather throws up pyrites or the reſiduum of their decompoſition.

14. To aſcertain by obſervations, and even by experiments, whether it may not be poſſible that pyrites or other ferruginous matters decompoſed by water, undergo a fermentation, which, acting on grand maſſes, may diſengage a ſufficient heat to produce the effects of a volcano.

15. Or whether, as M. Romme thinks, the fire of volcanoes is kept up by matters accumulated by rivers and currents of the ſea.

16. To ſearch for means of aſcertaining the depth of the focus of the volcano.

17. To examine whether, at the moment when an eruption begins to take place, there is any remarkable change in the tides, currents, ſprings, and the neareſt ſpiracles and volcanoes.

18. Muddy eruptions: their height, bulk, nature of the water they contain; whether it be ſaline: nature of the earth and ſtones thrown up; whether it contains ſea ſhells, of what kinds, and in what ſtate. Watery eruptions: the ſame re-

fearches: whether they hold in folution earths not ufually foluble in water *.

B. *Obfervations to be made at all Times on Volcanoes decidedly fuch.*

19. Nature of the countries and mountains between which they are found.

20. Hiftory of the volcano: its form, height, and extent in the moft ancient times; its fucceffive changes down to the prefent moment; its lateral mouths, and the epochs of their formation.

21. Chronology and enumeration of its different eruptions; defcription of them, and their moft remarkable characters.

22. To defcend, if poffible, into the craters of extinguifhed volcanoes; to meafure their depth; defcribe their form, the nature of their fides, their ftrata, and the concretions adhering to them, fuch as fulphur, falt, &c.

22. A. To obferve the *fumaroles*, or jets of fmoke, often acid, which arife; their temperature, their nature, and their effects on the lava with which they come in contact.

23. To examine the fiffures; whether they contain metallic or ftoney cryftallifations, which may be confidered as fublimed, and formed by the cryftallifation of fubftances reduced to the ftate of fmoke or vapour.

24. The nature of the ftreams of cooled lava; their extent and thicknefs.

25. Whether it be true that, in general, they are porous both at the upper and lower furfaces of the ftrata, and compact in the interior part.

26. To ftudy the nature of the different currents placed above each other, in order to afcertain the difference that may have taken place in the focus of the volcano, and even in the fource of its lava.

* To obferve thofe excavations from which confiderable currents of air iffue either periodically or conftantly. C.

27. To examine, in general, in the lava, the nature of the earth and ſtones of which it has been formed.

27. A. To ſtudy the origin of the cryſtals found incloſed in the lava, as the white garnets or leucites in that of Veſuvius, in order to aſcertain whether theſe cryſtals have been formed in the lava ſince the time of its fuſion, or whether they pre-exiſted in the ſtones from which the lava was produced.

28. The nature and progreſs of the decompoſition of the different kinds of lava, either by volcanic acids or meteors.

28. A. Whether there are any which have actually been in fuſion, and yet have preſerved all the external characters which the ſtone had before it was ſubjected to the action of the ſubterranean fires.

29. The origin of volcanic aſhes, pozzolanas, tarras, tufas, &c.

30. The origin of pumice ſtones: whether they are granites or feld-ſpars, aſbeſtos, phrenites, deodalites, or potter's clay more or leſs ferruginous, or, laſtly, the remains of the decompoſition of pit-coal.

30. A. Whether, as M. de Fichtel believes, the action of the fire of volcanoes may augment the fuſibility of feld-ſpar, and change it, in the ſame manner as quartz, into real zeolite.

31. Nature of the obſidians or volcanic glaſs: whether they be really glaſs, and the reſults of a complete fuſion; or whether they are not rather ſtones of a vitreous appearance, and which have not been expoſed to the action of a heat ſufficiently ſtrong to fuſe them.

32. Whether there exiſt ancient kinds of lava, which, as related of thoſe of Iſchia, are ſuſceptible of being heated by the moiſture of rain and fogs, which would ſupport the conjecture of No. 14.

C. Obſervations to be made on Hills and Mountains which are doubted to have been really Volcanoes.

33. The form, elevation, and other dimenſions of the hill or

or mountain, the volcanic origin of which may appear doubtful.

34. Situation of its ſtrata. To aſcend to the ſummit of thoſe which are inclined; to examine whether they have not a crater, or veſtiges of one.

35. To obſerve, above all, whether, in departing from the moſt elevated point, there are found ſtrata diverging in all parts, and proceeding from that point as a centre.

36. To ſtudy the characters of the ſtones which have been expoſed to the action of the fire, in order to diſtinguiſh them from other porous ſtones, ſuch as glandulous ſtones or amygdaloides.

37. When theſe characters are diſcovered, to examine whether, in the neighbourhood of the doubtful mountain, there are found ſcattered ſtones which exhibit the ſame characters, and which ſeem to have proceeded from that mountain.

38. To obſerve whether there are found, in the neighbourhood of the doubtful mountain, any veſtige of the remains of heat concealed in the boſom of the earth, as of thermal, or even acidulous waters. It is well known that theſe ſigns are equivocal, but their combination with others may throw ſome weight into the ſcale.

38. A. Whether there exiſt certain proofs of alternate depoſits of lava or other volcanic productions, and of matters accumulated or depoſited by the ſea.

39. Among the ſtones changed by the fire, to diſcover thoſe which may be conſidered as having been ſubjected to the action of one ſtratum of coal in deflagration, and which the celebrated Werner calls *pſeudo-volcanic*, and to diſtinguiſh them from thoſe which have been fuſed in a real volcano.

40. Baſaltes: their forms in columns, in beds, round maſſes; their connections, the relation which the baſaltes of theſe different forms obſerve with each other.

41. The nature of theſe baſaltes: that of their texture, of the points which they contain, of the pores and empty

or full cells that may be obſerved in them; of their different accidents and decompoſition.

41. A. The phenomena they exhibit in the fire, either expoſed to, or ſheltered from the action of the air. But before any arguments are drawn from theſe experiments, it will be neceſſary to reſolve the queſtion, Whether it be true that a ſtone may have been melted by ſubterranean fire, and yet none of its characters exhibit thoſe indications of fuſion which the fire of our furnaces would have given to the ſame ſtone.

42. Their connection, if there be any, with lava, fully aſcertained as ſuch: if it be true, for example, as M. Faujas affirms, that currents of lava are ſeen terminated by columns of baſaltes.

43. The nature of the baſes on which the baſaltes reſts: whether, as M. Werner ſays, any is found reſting on wacke or hornſtone, of an earthy and compact fracture, which itſelf repoſes on ſand or freeſtone.

44. Whether at other times baſaltes is ſeen to repoſe on beds of coal (*houille*) which preſent no indications of combuſtion.

45. In a word, to examine whether the ſoil which bears them, or the ſides of the veins in which they are contained, preſent indications of the action of fire, or at leaſt of having been expoſed to the contact of an incandeſcent maſs; or, on the contrary, whether there appear indications of depoſits of a ſubſtance which had been in a ſtate of aqueous fluidity.

46. Whether there are in the baſaltes veſtiges of organiſed marine bodies or others; and in what ſtate theſe veſtiges are found.

47. Whether there are obſerved, as M. Faujas ſays, baſaltes which ſeems to have formed a paſſage for itſelf from top to bottom through maſſes of granite.

48. In doubtful caſes of this kind it would be neceſſary, were it poſſible to be at the expence, to puſh a gallery under a rock of baſaltes, to examine whether the columns deſcend below

below the soil which seems to carry them; and if they are found below the soil, to sink a vertical well to ascertain the truth of the systems which suppose them to have been raised from the interior parts of the earth through the upper strata.

[To be continued.]

VIII. *Observations on the different Inducements to the Eating of Human Flesh. By* J. DE LOUREIRO *.

THE first inducement which can lead men to this excess is extreme hunger; but however pardonable it may be under such circumstances, if the flesh used be that of dead bodies, it is highly detestable on account of the consequences. During a dreadful famine in India, which destroyed more than a hundred thousand persons, when the roads and streets were covered with dead bodies, because people had not sufficient strength to inter them, I saw several have the resolution to preserve their lives by this disgusting food; but some of them, though not many, found it so delicious that when the famine was at an end they retained such an irresistible propensity to human flesh that they lay in wait for the living in order to devour them. Besides others, there was a mountaineer who concealed himself in a forest near the highway, where he used to cast a rope, with a noose, over the heads of the passengers, whom he afterwards cut to pieces to gratify his unnatural appetite. He had killed many persons in this manner, but he was at length caught and executed. At the same time, and owing to the same cause, a woman used to go out for the express purpose of carrying away children who had strayed from their homes. She stopped up their nose

* The author of this paper is an eminent Portuguese naturalist. A copy of it was given by the author from his own manuscript, never published, to Dr. G. H. Langsdorf, physician to Prince Christian of Waldeck at Lisbon, on the 5th of January 1798, who translated it into German, and sent it to Professor Voigt of Jena. See his *Magazin für den neusten zustand der Naturkunde*, Vol. I. part 3.

and

and mouth with clay that they might not call out for affiftance, and by thefe means fuffocated them. She confeffed the fact on being taken, and fome falted human flefh was found in her habitation. My fervant having entered it, obferved a girl of four or five years of age who had been fuffocated in the above manner, and who was lying wrapped up, half dead, in a mat. By employing proper means fhe was however reftored to life.

The reafon of the fecond inducement to anthropophagy will now be readily comprehended. We read in different works, both ancient and modern, that many nations, in various parts of the world, have killed men, not on account of famine, but of the delicious tafte of human flefh, which they not only fed upon but publicly fold.

The third inducement, that people eat their deceafed relations by way of fhewing them honour, feems to be as romantic as it is repugnant to nature; yet there are many authors, from Herodotus, the father of hiftory, down to modern times, who affert that this practice has prevailed among various nations.

A fourth incitement to eat human flefh is hatred and revenge. There is a law in Cochinchina, that all rebels, when convicted of their crime, fhall be executed, and that their flefh fhall be devoured by the king's loyal fubjects, and, in particular, by thofe who are neareft his perfon. At the time I refided in that country feveral executions of this kind took place. The men were beheaded, but the women were ftabbed. After the execution the foldiers who guarded the palace flocked around the bodies, and each cutting off, with a pocket knife, a fmall piece, dipped it in the juice of an unripe lemon, and in that manner fwallowed it. But as the fize of the morfel is not determined by the law, and as moft of the people have an averfion to fuch food, many fuffer the bit of flefh to drop through their fingers and fwallow only the lemon.

At the time when the Cochinefe were at war againft the

Mois,

Mois, a people who inhabit the mountains to the weſt, and who often make incurſions into their territories, the Cochineſe general marched with an army towards the mountains; but as he was not able to get at the enemy, on account of their inacceſſible ſituation, he ordered two priſoners he had taken to be put to death, and their fleſh to be devoured by his ſoldiers.

In the year 1777, being on board an Engliſh ſhip of war in Turon harbour, in order to return from Cochin-china to Europe, a party arrived there who had joined a powerful rebel named *Nhac*. This leader and his party had taken ſome of the king's confidential friends, and one in particular who had formerly done him a great deal of injury. The latter they put to death; and in order to gratify their revenge, they tore out his liver and ate it. The Cochin-chineſe, in general, when violently incenſed againſt any one, are accuſtomed to expreſs a wiſh that they may be able to devour his liver or his fleſh.

IX. *Deſcription of an improved Diſcharging Electrometer. Read before the Royal Society of Copenhagen.* By A. W. Von Hauch, *Marſhal of the Court, &c. to his Daniſh Majeſty* *.

NO branch of natural philoſophy can boaſt of having attracted ſo much attention as the doctrine of electricity; and indeed there are few which ſeem more worthy of inveſtigation. When we conſider the diſtinguiſhed part which electricity apparently performs in the grand operations of nature; the aſtoniſhing, and, on the firſt view, ſo inexplicable effects produced by this power of nature ſo different from thoſe of any other, and its ſecret and concealed mode of action, which the moſt acute obſervers have not hitherto been able to penetrate, it will not ſeem ſurpriſing that both the

* From the *Tranſactions of the Royal Society of Copenhagen.*

the learned and the unlearned should, with unabated zeal, have employed their attention on this phenomenon, as important to speculative philosophy as it is by its influence in society. Without this incessant attention our knowledge would not have made such rapid progress as it has done in the last forty years; and there might have been little difference between Otto von Guerick's balls of sulphur, or Hausen's glass globes, which were seventy years later, and the electric machine now in the Teylerian Museum at Haerlem. The former were scarcely sufficient to attract the lightest bodies, whereas the latter approaches near to nature in its strength, in its awful and wonderful effects; and seems to favour the possibility of the idea, that there are natural powers capable of impelling heavy bodies with prodigious force; and which, conducted by the hand of man, may, some centuries hence, banish the use of gunpowder, as the latter, a few centuries ago, banished bows and arrows.

Franklin conveyed electricity from the atmosphere, loaded a battery with it, and directed its mighty power with the same ease as that weak power excited by an electric machine. On account of the above-mentioned possibility of exhibiting the electric power in a certain degree and of a certain strength, it was found more and more necessary to have instruments proper for ascertaining these, and by which it might be determined with precision when and how a required effect could be produced.

Though these instruments have undergone many variations and improvements, and though there is an essential difference between Stephen Gray's or Du Fay's threads and the electrometers of Achard and Brooks *, they are all to be considered rather as announcers of electricity than as accurate gauges or measures, as they are all incapable of shewing its intensity. Another instrument, hitherto equally imper-

* A description of these Electrometers may be seen in Adams's and Cavallo's Treatises of Electricity, and in other works of the like kind. Edit.

fect,

fect, though no lefs important in electric experiments, is a difcharging electrometer; for, as it is believed that the laws of electricity can be defined with mathematical certainty *, it muft be of importance to be able to employ, with the fame certainty, the electric power which has been excited; and every inftrument tending to promote this object, though ftill imperfect, muft be of fome utility, and be not unacceptable to thofe fond of electrical experiments. All the difcharging electrometers hitherto known, perform their effect either by fpontaneoufly difcharging, as that of Lane, or as Henley's general difcharger, &c. and in this cafe are affected by the greater or lefs conducting property of the air, which muft neceffarily be changed on each change of the atmofphere, and therefore muft render the inftrument very imperfect and incorrect; or the effect is produced by introducing a conducting body between two electric atmofpheres, and by thefe means uniting them. But as this muft depend on the greater or lefs dexterity of the perfon who performs the experiment to determine the proper moment for difcharging, and as another electrometer is at the fame time neceffary, this method of difcharging is as uncertain as the firft.

I have endeavoured, therefore, to conftruct an inftrument to fupply this deficiency; and I hope it will not be found unworthy of attention. It is an electrometer which, though founded on the fame principles as that of Brooks, that is, on comparing the effect of the repulfive power of electricity between two bodies of a given fize with the known weight requifite to produce that effect, has, in my opinion, fome improvements which are wanting in the other; for the ftate of the barometer has no influence upon this electrometer, as it has on that of Brooks; nor does friction, which is far from being unimportant, here take place. But as this in-

* See Lord Stanhope's *Principles of Electricity*, 3d, 4th, and 5th parts; and Coulomb's defcription of an inftrument by which it is proved that the effect of the electric matter is in the inverfe ratio of the fquare of the diftance.

ftrument

ſtrument is intended to be uſed as a diſcharging electrometer, and muſt be examined as ſuch, no compariſon can properly be made between it and any of the other electrometers hitherto employed.

Plate VI contains a repreſentation of the electrometer, and the different parts of which it conſiſts. OP is a board of dry mahogany, twelve inches in length and four in breadth, which ſerves as a ſtand for the inſtrument. In this board are faſtened two maſſy glaſs pillars, M and N, which ſupport the two braſs capes or rings GG, with the two forks of tempered ſteel KK ſcrewed into them. The two rings GG are well covered with varniſh.

In the ring G is faſtened a braſs rod, which terminates in a ball E of the ſame metal, and an inch in diameter. The length of the rod and ball together is four inches and a half.

A very delicate beam, AB, the arms of which are of unequal length, moves on a ſharp triangular axis (a knife edge) of well tempered ſteel on the fork K of the pillar M. It is ſeventeen inches in length, and ſo conſtructed that the ſhort arm forms a third and the long one two-thirds of the whole beam. The ſhort arm of braſs furniſhed with the ball B, exactly of the ſame ſize as the ball E, is divided into forty-five parts equivalent to grains. The long arm A is of glaſs covered with copal varniſh, and ends in an ivory ball A, into which is fitted an ivory hook R, deſtined to ſupport the ivory ſcale H. In order to render the inſulation more complete, this ſcale is ſuſpended by three hairs.

A very delicate beam, CD, eleven inches in length, moves on an axis, like the former, on the pillar N, though not here ſhewn. This beam is proportioned in the ſame manner, one arm being a third and the other two-thirds of the whole length. The long arm of braſs is furniſhed at the end with a ball D, and divided into thirty parts correſponding to grains. The ſhort arm of glaſs terminates in a long roundiſh plate C, covered with copal varniſh. The ſteel

forks

forks are fhewn by the fections of the two brafs caps FF, as are alfo the two knife edges LL. By thefe caps the efcape of the electric matter is partly prevented.

A brafs ring Q, capable of being moved along the fhort arm of the upper beam AB, fhews, by means of marks determined by trial and cut out on the beam, the number of grains which muft be placed in the fmall fcale to reftore the equilibrium of the beam at each diftance of the ring Q from the point of fufpenfion.

On the long arm CD of the lower beam there is alfo a moveable ring S, which, like the ring Q, fhews in grains, by its diftance from the point of fufpenfion, the power requifite to overcome the preponderance of LD in regard to LC.

The power neceffary for this purpofe will be found if the fhell H, which weighs exactly fourteen grains, be fuffered to fink down on the glafs plate C, and the ring S be pufhed forwards till both the arms of the beam are in equilibrium. The part of the beam on which the ring S has moved is divided into fourteen parts, fo that *o* marks the place where the ring S muft ftand when the beam, in its free ftate, is in equilibrium; and 14 ftands at the place where the ring S again reftores a perfect equilibrium when the fhell H is laid on the glafs plate C. Each of thefe parts, which are divided into quarters, indicates a grain. The lower divifions of the fcale will be found with more accuracy if quarters of a grain be put, in fucceffion, into the fhell H (after it has been laid on the plate C), and the ring S be moved between each quarter of a grain until the perfect equilibrium be reftored. This place on the beam is then to be marked, and you may continue in this manner until the 30th part of a grain be given. Both fcales, for the fake of diftinctnefs, are divided only fo low as quarters of a grain; though the inftrument is fo delicate, and muft abfolutely be fo, that 1-20th of a grain is fufficient to deftroy the equilibrium.

The two glafs pillars M and N, together with the fteel forks

forks affixed to them, are so fitted into the stand that both the beams lie parallel to each other as well as to the rod GE. In this position of the beams AB, the balls B and E are just in contact. The smallest glass pillar N is of such a height that the ball of the beam CD stands at the distance of exactly four lines from the ring G, and cannot move without touching the latter. The small shell H is suspended in such a manner that there is a distance of exactly two lines between it and the shell C. In each of the brass rings GG is a small hole, that the instrument may be connected with the two sides of an electric jar. I is a brass wire, with a hollow bit of ivory *a* destined to support the beam CD, which is necessarily preponderant at D, in order to prevent oscillation between the discharges to be examined by the instrument.

It may be readily comprehended that, when the beam AB has moved, A must pass over twice the space that B does; and that, in the beam CD, the case is the same in regard to C and D. If AB therefore be connected with the external side, and CD with the internal side of a battery, but in such a manner that the instrument is at a sufficient distance beyond the electric atmosphere; and if the battery be charged, the repulsive effect of the electric power will oblige the ball B to separate from the ball E; the shell H must therefore naturally sink down with double velocity, so that when the ball B rises a line, the shell H must sink two: when it reaches this depth it will touch the shell C, and the latter, by the power excited in it, will be obliged to sink, by which D must naturally again ascend in a double proportion to the sinking of C; so that when C has fallen two lines, D must have ascended four, and D that moment touches the ring by which the two sides of the battery are connected with each other, and discharges the battery.

But, as the attractive electric power between unlike atmospheres, under like circumstances, is at least as strong as its repulsive power between like atmospheres, it would thence follow that the electric power, instead of repelling the ball B from

from the ball E would rather attract D, and, by its contact with G, promote the diſcharging; by which the inſtrument would fail of its object, and be ſubjected to the temperature of the atmoſphere like all other electrometers; and beſides this, the electric power could no longer be determined by weight. To obviate this inconvenience, the inſtrument, in all electrical experiments, muſt be applied in ſuch a manner that the power with which the ball D is attracted by AB may exceed in ſtrength the power required to repel the ball B from the ball E. For this purpoſe the ring S muſt always be removed two diviſions farther on CD, towards D, than the ring Q is ſhifted on AB towards B. If, for example, an electric force were required equal to eight grains, according to this electrometer, the ring Q muſt be removed to the place where 8 ſtands, and the ring S to the place marked 10. The repulſive power will then naturally repel the balls B and E before G is in a condition to attract the ball D, as a power of two grains would be neceſſary for this purpoſe, beſides that of the eight already in action. The ſhell H, with its weight of fourteen grains, will eaſily overcome the preponderance of LD over LC, as it amounts only to ten grains, and therefore nothing exiſts that can impede the diſcharging.

When the ring S, according to the required power, is removed ſo far towards D that the ſhell H is not able by its weight to deſtroy the preponderance of LD in regard to LC, the active power of the ſhell H muſt be ſo far increaſed by the addition of weights that it can act, with a preponderance of four grains, on the plate C. If, for example, an electric power of fourteen grains be required, the ring S muſt be removed to 16, by which LD reſts upon *a*, with a preponderance of ſixteen grains in regard to LC. Now to make H act on the plate C with a preponderance of four grains, it muſt be increaſed to twenty grains, that is, ſix grains weight more muſt be added, as it weighs only fourteen; which ſix grains are again laid upon LB; and therefore the ring Q is ſhifted to 20, as the

 ſtrength

ſtrength of the repulſive power is pointed out by fourteen grains.

If an electric power of twenty-five grains be required, the ring S muſt be removed to 27, and the weight of ſeventeen grains be put into the ſhell H in order to produce a preponderance of four grains in regard to S. Theſe ſeventeen grains are added to the required power of twenty-five grains, and the ring Q is puſhed to 42, &c. In this manner the repulſive power always acts before the attractive power can.

It may be readily perceived that the faults and inconveniences common to all the electrometers hitherto employed, and which have been already mentioned, cannot take place here; becauſe the diſcharging is performed by immediate connection between the poſitive and negative electricity in the inſtrument itſelf, without any external means being employed.

One of the moſt eſſential advantages of this inſtrument is, the certainty with which the ſame reſult may be expected when the experiment is repeated. For the ſame degree of electric power, whatever be the temperature of the atmoſphere, will always be neceſſary to commence the ſeparation of the two balls B and E from each other, the quantity of coated glaſs and the diſtance of the ring Q from the axis L being the ſame.

Another no leſs important advantage of this inſtrument is, that in an experiment where the ſame electric power, often repeated, is neceſſary to aſcertain the reſult with accuracy; ſuch, for example, as the charging a battery through acids, water, &c.; the ſame degree of precaution is not neceſſary as is indiſpenſibly ſo in any other electrometer, as the perſon who puts the machine in motion has nothing to do but to count how often the electrometer diſcharges itſelf; and the inſtrument may be incloſed in a glaſs caſe, or prevented in any other manner from external contact, or any other circumſtances which might render the experiment uncertain.

I flatter

I flatter myfelf that the fimplicity of the conftruction of this inftrument, the facility with which it may be made at a very fmall expence, and the certainty that two inftruments, prepared according to the fame fcale, with a like quantity of coated glafs, muft exactly correfpond with each other; but, above all, that the certainty and accuracy by which experiments may be made with it, and by thefe means be accurately defcribed, are advantages which will not be found united in any of the electrometers hitherto invented.

X. *Obfervations on the Tones produced by an Organ-pipe in different Kinds of Gas.* By C. F. F. CHLADNI *.

AIR, it is well known, is the moft common conductor of found; but it can become a fonorous body alfo. The latter is the cafe in regard to a pipe, as the pipe itfelf does not emit found, but the column of air included in it, and which, being feparated from the reft of the atmofphere, is obliged, by blowing, to vibrate in fuch a manner that it contracts and expands longitudinally in various ways; and thefe vibrations are then conducted to a diftance by the furrounding air. It is not neceffary that I fhould here farther explain the different kinds of vibration of which the air in a pipe is fufceptible. Thofe who are defirous of information on this fubject may confult Daniel Bernoulli's papers in the Memoirs of the Academy of Paris for 1762; thofe of Lambert, in the Memoirs of the Academy of Berlin for 1775; and of Euler, in the Sixteenth Volume of the New Tranfactions of the Imperial Academy of Peterfburgh.

The conducting of found through the air, and the vibrations of air in a pipe, depend on the fame laws. This will readily appear from the following obfervation, befides others, that the velocity of the vibrations, under like circumftances,

* From *Voigt's Magazin für den neveften zuftand der Naturkunde*, Vol. I. part 3.

depends

depends merely on the length of the pipe, and not on its diameter; ſo that the velocity is not changed when the pipe is indefinitely enlarged, or, what is the ſame thing, when it is totally removed, ſo as to afford free acceſs to the air on all ſides. Sound therefore is diffuſed through a certain ſpace of air, in the ſame time in which a column of air incloſed in a pipe makes one vibration; a propoſition which has been proved in the before-mentioned papers of Euler, Bernoulli, and Lambert, and alſo by Count Giordano Riccati in his Treatiſe on Elaſtic Fibres or Strings, and which is confirmed by experience. Hence it follows, that the number of the vibrations made by the air in a pipe may be found, if the real velocity with which ſound is conducted through the air be divided by the length of the column of air contained in the pipe.

The labours undertaken by Newton, Euler, Daniel Bernoulli, Lambert, Giordano Riccati, and others, to determine, from general mechanical principles, the velocity with which ſound is conducted, have given no other reſults than thoſe taught by experience. By all theſe theoretic reſearches the ſpace through which ſound paſſes in the air, or, in general, in any expanſible fluid ſubſtance, was found to be $= \sqrt{\frac{2ga}{b}}$; where g is the ſpace through which a heavy body falls in a ſecond, or in any given time; a the elaſticity of the expanſible fluid, which is aſſumed equal to the preſſure it ſuſtains from the atmoſphere; and b the denſity of the expanſible fluid: a may be alſo the height of the barometer, if the denſity of the mercury be conſidered as 1. Theory gives, therefore, about 900 Pariſian feet as the diſtance to which ſound is tranſmitted through the air in the courſe of a ſecond; whereas this ſpace has been found, by experience, to be equal to about 1038. No one has ever yet aſſigned a ſufficient reaſon for this difference. The moſt common conjecture is, that it muſt be owing to a mixture of various foreign particles; but this, by thoſe acquainted with

with the nature of atmofpheric air and the different kinds of gafes, as afcertained by chemical experiments, can hardly be admitted, and is contradicted by this circumftance: that, according to every obfervation, the ftate of the air, whether moift or dry, cloudy or rainy, does not alter, or at leaft in a fenfible manner, the velocity with which found is conducted. Various other conjectures feem to be equally inconfiftent with nature. From the prefent experiments it follows, in my opinion, that the velocity of the vibrations of an expanfible fluid fubftance cannot be determined by the mechanical principles hitherto admitted alone; but that it depends, befides thefe, upon other properties.

Were the before-mentioned data fufficient to determine the vibrations of an expanfible fluid, the tone which a pipe can emit, both in the air and in different kinds of gafes, under like circumftances, would be inverfely as the fquare root of the fpecific gravity of the expanfible fluids. The refult given by the prefent experiments is, however, different. As I was not furnifhed with the apparatus proper for the purpofe, I requefted, during my refidence at Vienna, profeffor Jacquin junior, who has a great zeal for the progrefs of fcience, to undertake the experiments; and he was fo good as to comply with my wifhes.

The apparatus confifted of an open tin organ-pipe, in which the length of the vibrating column of air from the aperture where the inflated air iffues to the end was about fix inches, having its upper end inferted in the neck of a bell-glafs, that could be clofely fhut by means of a cock. On immerfing the bell in water, the pipe was at the fame time filled with it, to guard againft all mixture of atmofpheric air. A bladder, furnifhed alfo with a cock, was fcrewed upon the neck of the bell, after having been compreffed as much as poffible, and emptied of air by applying the mouth to it. The bell and the bladder were then filled with fuch a quantity of the air to be examined, that the water, in which the bell was immerfed, ftood at an equal

height both in the infide and outfide; and the preffure fuftained by the bell was equal, therefore, to the preffure of the atmofphere. The pipe was blown by compreffing the bladder; but the greateft caution was neceffary to prevent the pipe from emitting, inftead of its natural tone, any of its higher tones, which in an open pipe, as is well known, are as the natural feries of the numbers, that is, in arithmetical progreffion. A weak and uniform preffure was therefore neceffary, but which could be repeated at pleafure; becaufe, when the preffure was omitted, the fuperfluous gas returned back into the bladder. The temperature, which certainly contributes in fome degree to vary the tone of a wind inftrument, in regard to all the different kinds of gas, was always the fame; that is, the degree which is ufual on a fomewhat cool morning in fpring. To enable me to judge with more accuracy of the tone, I had tuned two ftrings to an unifon of that tone produced in common air: the experiments were made with the utmoft accuracy, fo that I have reafon to think there was no room left for the fmalleft deception.

The bell and the pipe being firft filled with common air, the tone was exactly the fame as that of a pipe blown when it is perfectly free; but much weaker, as muft have been expected, becaufe the vibrations of the air inclofed in the bell were propagated, and could be communicated to the furrounding atmofphere only through the fides of the bell and through the water. But though the found, for the fame reafon, was fomewhat weak in the other experiments, they could, however, be heard very diftinctly.

In oxygen gas from manganefe the found was half a tone or nearly a whole tone lower than in common air. This nearly agrees with theory; according to which the difference muft amount to almoft half a tone, if the gravity of atmofpheric air be to that of oxygen gas as 1 to 1·103, and the tone inverfely as the fquare root of the gravity.

The moft ftriking deviation from theory was exhibited by azotic gas. It might have been expected that the found of

it

it would have been a little higher than that of common air, becaufe it is fomewhat lighter, and becaufe its gravity is to that of atmofpheric air as 0·985 to 1; but it was half a tone lower. Three kinds of azotic gas were tried; one produced by means of liver of fulphur, another by a mixture of iron and fulphur, and the third from common air by means of nitrous gas.

In all the three a taper was extinguifhed in a moment, and they all gave the fame tone. Should it be here fufpected that the azotic gas difengaged from atmofpheric air by fulphur and iron, might have had a mixture of hydrogen gas, the tone in that cafe muft have been raifed rather than lowered by the latter on account of its lightnefs. We may therefore confider it as certain, that the vibrations of azotic gas, let it be prepared in whatever manner it may, are much flower than the vibrations of atmofpheric air; and that the difference amounts to about half a tone. It is remarkable that azotic gas in particular fhould exhibit, in regard to its vibrations, fuch a variation from the common theory, as, according to late experiments, it differs fo much from other kinds of gafes in regard to its expanfibility at different degrees of heat. It would be well worth the trouble to repeat thefe experiments, refpecting the vibrations of azotic gas, at different high and low degrees of temperature. It ought alfo to be examined with more accuracy, whether Marriot's law, that at the fame temperature the denfity of an expanfible fluid increafes and decreafes in proportion to its preffure, may not admit of fome exception in regard to azotic gas; as this inquiry would, in all probability, enable us to explain the variation of its vibrations from the common theory.

A very remarkable phenomenon was exhibited by a mixture of azotic and oxygen gas. It might have been fuppofed, that azotic gas, being a lighter fubftance, would have occafioned a higher tone than atmofpheric air; and oxygen

gas, as a heavier ſubſtance, a lower tone; and that a mixture of theſe two would have given a mean tone between both. Experience, however, ſhews that each of theſe two expanſible fluids, as I have already ſaid, gives a higher tone than atmoſpheric air; and that a mixture of them gives a tone higher than either of theſe can give alone, and perfectly ſimilar to the tone of atmoſpheric air. The quantity of oxygen gas mixed with the azotic gas might, according to appearance, be at firſt about a fourth; afterwards a third, or ſomewhat more; which however made no conſiderable variation in the tone. I am of opinion, therefore, that the unknown cauſe which occaſions a mixture of theſe two ſubſtances to vibrate quicker than each of them taken ſingly, may alſo occaſion ſound to be conducted with greater velocity than it ought, according to common theory, through atmoſpheric air, which has the ſame component parts as the above mixture. This greater velocity ſeems to imply rather a chemical than a merely mechanical mixture of theſe fluids. But this is contradicted, beſides other obſervations, by one in particular of that acute and diligent philoſopher Profeſſor Remigius Dottler of Vienna, who ſuffered common air to ſtand above a year untouched in a glaſs tube five feet in length and one and a half in diameter, which was well ſtopped both at top and bottom, and at the end of that time the component parts of the air were in ſome meaſure ſeparated from each other according to their ſpecific gravity; ſo that a lighted taper was extinguiſhed in the lighter azot found at the top, while another burnt in the heavy oxygen gas at the bottom with more ſtrength than in atmoſpheric air.

Hydrogen gas gave a far higher tone than atmoſpheric air; with that extricated by iron and the ſulphuric acid, the difference was about an octave; with that by zinc and the muriatic acid, it was nearly an octave and a whole tone; by that from the ſteam of water conducted through a tube of ignited iron, it was ſomewhat above an octave and a ſmall third.

third. This difference, however, is not so great as might have been expected from so light a gas, the gravity of which is to that of common air, when the gas is perfectly pure, as 0·084 to 1. Had the tones, therefore, been inversely as the square roots of the gravity, the tone with hydrogen gas from iron and the sulphuric acid, allowing it to have been only six or seven times lighter than atmospheric air, must have been about an octave and a large third higher; and by the lighter hydrogen gas, about an octave and a small seventh higher. By mixing atmospheric air with hydrogen gas, the tone, as might readily be expected, was lowered; but it is to be remarked, that as long as these two fluids were not uniformly mixed by filling and compressing the bladder, a discordant noise only was heard, and not a distinct sound, as the vibrations could not be isochronous, which forms the only essential difference between a distinct sound and such a discordant noise. The same thing was observed in regard to the before-mentioned mixture of azotic and oxygen gas.

The tone of carbonic acid gas from chalk and the sulphuric acid was almost a large third lower than the tone of atmospheric air; which agrees pretty well with theory, since the gravity of these fluids is as 1·5 to 1.

Nitrous gas from nitrous acid and copper was not very favourable to sound; and it required a strong pressure of the bladder and a great deal of caution, because, instead of the wished-for low tone, one of the higher tones was produced. The lowest tone, obtained with considerable difficulty, was about half a tone lower than in atmospheric air; which agrees also pretty well with theory, since this gas is heavier, and the gravities are as 1·195 to 1: the tone was also almost like that in azotic gas, notwithstanding the considerable difference in the gravities of these two fluids.

As to the velocity with which the sound of another elastic body would be conducted through these gases, could a sufficient extent of them be procured to make the observation, it follows, from what has been said in the beginning of this

paper,

paper, that with equal preſſure they would be in the ratio of the tones above mentioned.

The preſent experiments are very different from thoſe of Prieſtley and Perolle on ſound in different kinds of gaſes. The experiments of theſe two philoſophers had relation only to the intenſity with which the vibrations of another elaſtic body (of a bell ſtruck by a hammer) are conducted through theſe gaſes. Perolle contradicts Prieſtley's aſſertion, that the power of conducting is as the denſities; but to this rule Prieſtley himſelf makes an exception in regard to oxygen gas, which appears to be a ſtronger conductor: azotic gas was examined by neither of theſe philoſophers. In hydrogen gas they both found the conducting power very weak, which is no doubt owing to its little denſity. In oxygen gas they found the ſound ſomewhat ſtronger than in common air; in the nitrous gas Perolle found it alſo ſomewhat ſtronger. In carbonic acid gas Prieſtley found the ſound ſtronger; but Perolle, weaker, duller, and ſomewhat lower than in common air: which laſt circumſtance I conſider as agreeable to truth, becauſe the vibrations of a ſounding body muſt be more retarded the denſer the ſurrounding fluid is, or according to its greater preſſure on that body. For this reaſon the vibrations of a body vibrating in our atmoſpheric air muſt be a little ſlower than they would be in a vacuum; as experience teaches that the ſound of a bell becomes lower the more it is filled with water, or the deeper it is immerſed in that fluid; ſo that, when it is ſtruck at a conſiderable depth, it no longer emits a diſtinct ſound, but rather a kind of diſcordant noiſe.

XI. *Letter*

XI. *Letter from* E. Perolle *of the Academy of Turin, formerly Professor of Anatomy and the Practice of Medicine at Toulouse, to* J. C. de la Metherie, *on the Acoustic Experiments of* Chladni *.

I Read in your Journal of Messidor, 6th year, and in the *Bulletin des Sciences*, published by the Philomatic Society of Pluviose the same year, a short account of the experiments made by Chladni and Jacquin at Vienna, with a view to determine the sonorous properties of various gaseous substances. By causing a small tin pipe, brought into contact with a cock in the neck of a bell glass, to be blown by gas contained in a bladder applied to the external aperture of the cock, these philosophers observed, that the sound was a semitone lower with azotic and oxygen gas than with atmospheric air; a third lower with carbonic acid gas; and nearly the same with nitrous gas: but, with oxygen gas, from nine to eleven tones higher than with the air that surrounds us. A mixture of azote and oxygen, in the same proportions as in atmospheric air, gave the same tone as the latter; but when the mixture of these gases was not uniform, the sounds were totally discordant. The singularity of these results induced me to examine the experiments with attention.

Priestley †, several years ago, published some observations on the same subject; but he had made use of a metallic body rendered sonorous by percussion, after he had fixed it in a glass jar, which he filled successively with different kinds of gas. The aëriform substances which he employed for his experiments appeared to him to propagate sounds in proportion to their density: he remarked, that in hydrogen gas the sound seemed like that produced in a vacuum or air highly rarefied. Is it to be supposed that such a philosopher as Priestley would have failed to discover the alteration of tones produced in the various

* From the *Journal de Physique*, an. 7.

† See *Observations and Experiments on different Branches of Philosophy*, Part III. p. 355.—Priestley made no experiments with nitrous gas.

rious aëriform substances? His ear would certainly have distinguished the falling of a third in the carbonic acid and nitrous gases; and he must, no doubt, have been struck with the prodigious rise occasioned by the hydrogen.

At the time Priestley made his experiments I was engaged in some of the same kind, the results of which were published in the Memoirs of the Academy of Sciences of Turin for the years 1786 and 1787. In my paper it may be seen that I successively filled a bottle, and inverted it in a pneumato-chemical preparation of various aëriform substances; and in these atmospheres I rung a small bell, and made a repeating-watch strike. As the sounds reached my ear, I paid attention to the variations they exhibited in regard to the tone, its intensity, and the vibration. To assist my ear I made use of a violin. Some idea may be formed of the result of my labours, by casting an eye over the first table of my memoir, of which the following is a copy:—

Nature of the Gases examined.	*Tone of the Sounds in different Airs.*	*Nature or Species of the Sound.*	*Distance at which they may be heard.*
1. Atmospheric air serving for a point of comparison.			56 feet 6 inches.
2. Fixed air, drawn from chalk by diluted nitrous acid.	Alike, or a little lower than in the preceding experiment.	Considerably duller.	48 feet 5 inches.
3. Vital air extracted from red precipitate.	Seemed a little sharper than in common air.	Clearer than in atmospheric air.	63 feet.
4. Nitrous air produced by a nitrous solution of tin.	Nearly like the former.	Ditto.	Ditto.
5. Inflammable air produced by the action of diluted vitriolic acid on steel filings.	Not very distinct: it seemed rather a weak noise than a proper tone.	Had no harmony, no strength; and seemed to die away at	11 feet.

Chladni's experiments, therefore, feem to contradict thofe made by Prieftley and myfelf. To reconcile them, it will no doubt be faid that Chladni and Jacquin employed a wind-inftrument, and that my experiments and thofe of Prieftley were made with metallic bodies rendered fonorous by percuffion. But whence does it happen that thofe fluids, fome of which lower the found of a pipe one-third, while another makes the found of the fame pipe from nine to eleven tones higher, have not power to alter the tones of a metallic body in any fenfible degree? I fhall here offer a few remarks which feem to arife from thefe general obfervations.

In a mixture of oxygen and azote, in the fame proportions as in the atmofpheric air, found is the fame, according to Chladni and Jacquin, as in the latter medium; but they add, if the mixture of thefe two gafes is not complete, the found is quite difcordant. What! do oxygen and azote afford each of them the fame found? and does an incomplete mixture of them produce a difcordant found? It will no doubt be replied, that azote and oxygen do not give the fame tone as atmofpheric air; but, in theatres, ball-rooms, concert-rooms, &c. where a great number of fpectators are affembled, and where there is a fufficient quantity of carbonic acid, which does not combine with the air of the atmofphere, has it ever been obferved that wind inftruments were difcordant? If an incomplete mixture of atmofpheric air with gas, which lowers the found one third, does not render the founds difcordant, how can we perfuade ourfelves that a mixture of two gafes, which caufe a falling of only half a tone, fhould occafion a found altogether difcordant, merely becaufe the portions of the gafes are completely mixed, while the admixture of fome other particles is much lefs complete?

The above authors inform us alfo, that in hydrogen gas the found rifes nine or eleven tones. Here there can be no medium. Either the found produced in the hydrogen is fharper by nine tones, and in that cafe the elevation ought

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not to be carried to eleven; or the found is fharper by eleven tones in the hydrogen than in atmofpheric air, and then it is wrong to fay that it rifes only nine tones.

This want of correctnefs and precifion in determining the tone; this great latitude allowed to the hydrogen, of being able to raife the found nine or eleven tones; does it not prove an indecifion, an uncertainty on the part of thefe philofophers, little calculated to procure confidence to their experiments?

Let it not, however, be imagined, that I wifh to conteft the reality of their difcoveries. Not having repeated the experiments of thefe authors, I can have no fuch intention. I have only endeavoured to give an account of thofe doubts which remained on my mind after I had taken the fubject into confideration, and to engage the philofophers to remove the uncertainty by repeating the experiments.

One of thefe authors, Chladni, has made an obfervation which feems entirely his own. He obferved, that when a plate of glafs is agitated by means of a bow, if fome duft is ftrewed over the glafs, the former will appear to have arranged itfelf fymmetrically, after the plate ceafes to emit found. Under the like circumftances the figures are always the fame.

It is not at all furprifing, that an elaftic body, when put in motion by the fame means, fhould conftantly experience effects of the fame kind. The light body placed on the furface of the glafs with which the experiment is made, only confirms what we were already taught by reafon. But before it be concluded that thefe motions produce found, or tend to determine the tone, philofophers are invited to read my Letter to De la Metherie *On the Total Vibrations of Sonorous Bodies*, publifhed in the *Journal de Phyfique* for December 1785. This letter, the fenfe of which is altered by fome typographical errors *, contains facts a little too precife

* P. 424, at the end of the firft line, add *adjoutez*; fame page, at the beginning of the 11th line, for *fon* read *ton*; next line, for *anneau* read *arceau*.

perhaps,

perhaps, but which do not appear to me the less to merit the attention of the learned.

Philosophers, in my opinion, will find some curious observations on this subject also in my *Inquiries into the Propagation of Sound in different Solid as well as Fluid Mediums*; which will soon appear.

XII. *On a Submarine Forest on the East Coast of England.* By Joseph Correa de Serra, LL. D. F. R. S. *and* A. S.*

In Geology, more perhaps than in any other branch of Natural History, there exists a necessity of strictly separating the facts observed from the ideas which, in order to explain them, may occur to the mind of the observer. In the present state of the science, every well ascertained fact increases our still narrow stock of real knowledge; when on the contrary, the reasonings we are enabled to make are at best but ingenious guesses, which too often bias and mislead the judgement. I shall, therefore, endeavour in this paper to give, first, a mere description of the object unmixed with any systematical ideas, and shall afterwards offer such conjectures on its causes as seem to me to be fairly grounded on observation.

It was a common report in Lincolnshire, that a large extent of islets of moor situated along its coast, and visible only in the lowest ebbs of the year, was chiefly composed of decayed trees. These islets are marked in Mitchell's chart of that coast by the name of *clay huts*; and the village of Huttoft, opposite to which they principally lie, seems to have derived its name from them. In the month of September 1796 I went to Sutton, on the coast of Lincolnshire, in the company of the Right Hon. the President of the Royal Society, in order to examine their nature and extent. The

* From the Philosophical Transactions, 1799.

19th of the month, being the firft day after the equinoctial full moon, when the loweft ebbs were to be expected, we went in a boat about half paft twelve at noon, and foon fet foot upon one of the largeft iflands then appearing. Its expofed furface was about thirty yards long, and twenty-five wide, when the tide was at the loweft. A great number of fmaller iflets were vifible around us, chiefly to the eaftward and fouthward; and the fifhermen, whofe authority in this point is very competent, fay, that fimilar moors are to be found along the whole coaft, from Skegnefs to Grimfby, particularly off Addelthorpe and Mablethorpe. The channels dividing the iflets were, at the time we faw them, wide, and of various depths; the iflands themfelves ranging generally from eaft to weft in their largeft dimenfions.

We vifited them again in the ebbs of the 20th and 21ft; and though it did not generally ebb fo far as we expected, we could notwithftanding afcertain that they confifted almoft entirely of roots, trunks, branches and leaves of trees and fhrubs, intermixed with fome leaves of aquatic plants. The remains of fome of thefe trees were ftill ftanding on their roots, while the trunks of the great part lay fcattered on the ground in every poffible direction. The barks of trees and roots appeared generally as frefh as when they were growing; in that of the branches particularly, of which a great quantity was found, even the thin filver membranes of the outer fkin were difcernible. The timber of all kinds, on the contrary, was decompofed, and foft in the greateft part of the trees: in fome, however, it was firm, efpecially in the roots. The people of the country have often found among them very found pieces of timber, fit to be employed for feveral economical purpofes.

The forts of wood which are ftill diftinguifhable, are, birch, fir, and oak. Other woods evidently exift in thefe iflets, of fome of which we found the leaves in the foil; but our prefent knowledge of the comparative anatomy of timber is not fo far advanced as to afford us the means of pronouncing with

with confidence respecting their species. In general the trunks, branches, and roots of the decayed trees were considerably flattened; which is a phenomenon observed in the *surtarbrand*, or fossil wood of Iceland, and which Scheuchzer remarked also in the fossil wood found in the neighbourhood of the lake of Thun in Switzerland.

The soil to which the trees are affixed, and in which they grew, is a soft greasy *clay*; but for many inches above its surface, the soil is entirely composed of rotten leaves scarcely distinguishable to the eye, many of which may be separated by putting the soil in water, and dexterously and patiently using a spatula or blunt knife. By this method I obtained some perfect leaves of *Ilex aquifolium*, which are now in the herbarium of the Right Honourable Sir Joseph Banks; and some other leaves, which, though less perfect, seem to belong to some species of willow. In this stratum of rotten leaves we could also distinguish some roots of *Arundo phragmites*.

These islets, according to the most accurate information, extend at least twelve miles in length, and about a mile in breadth, opposite to Sutton shore. The water without them, towards the sea, generally deepens suddenly, so as to form a steep bank. The channels between the several islets, when the islets are dry, in the lowest ebbs of the year are from four to twelve feet deep: their bottoms are clay or sand, and their direction is generally from east to west.

A well, dug at Sutton by Joshua Searby, shows that a moor of the same nature is found under ground in that part of the country at the depth of sixteen feet, consequently very nearly on the same level with that which constitutes the islets. The disposition of the strata was found to be nearly as follows:——Clay, 16 feet—Moor, similar to that of the islets, 3 to 4 ditto—Soft moor, like the scowerings of a ditch bottom, mixed with shells and silt, 20 feet—Marly clay, 1 foot—Chalky rock, from 1 to 2 feet—Clay, 31 yards—Gravel and water; the water has a chalybeate taste.

In order to aſcertain the courſe of this ſubterraneous ſtratum of decayed vegetables, Sir Joſeph Banks directed a boring to be made in the fields belonging to the Royal Society in the pariſh of Mablethorpe. Moor of a ſimilar nature to that of Searby's well, and the iſlets, was found, very nearly on the ſame level, about four feet thick, and under a ſoft clay.

The whole appearance of the rotten vegetables, we obſerved, perfectly reſembles, according to the remark of Sir Joſeph Banks, the moor which, in Blankeney Fen and in other parts of the Eaſt Fen in Lincolnſhire, is thrown up in the making of banks; barks, like thoſe of the birch-tree, being there alſo abundantly found. The moor extends over all the Lincolnſhire fens, and has been traced as far as Peterborough, more than ſixty miles to the ſouth of Sutton. On the north ſide, the moory iſlets, according to the fiſhermen, extend as far as Grimſby, ſituated on the ſouth ſide the Humber: and it is a remarkable circumſtance, that in the large tracts of low land which lie on the ſouth banks of that river, a little above its mouth, there is a ſubterraneous ſtratum of decayed trees and ſhrubs exactly like thoſe we obſerved at Sutton; particularly at Axolme iſle, a tract of ten miles in length by five in breadth; and at Hatfield Chace, which comprehends one hundred and eighty thouſand acres. Dugdale * had long ago made this obſervation in the firſt of theſe places; and De la Pryme † in the ſecond. The roots are there, likewiſe, ſtanding in the places where they grew: the trunks lie proſtrate. The woods are of the ſame ſpecies as at Sutton. Roots of aquatic plants and reeds are likewiſe mixed with them; and they are covered by a ſtratum of ſome yards of ſoil, the thickneſs of which, though not aſcertained with exactneſs by the above-mentioned obſervers, we may eaſily conceive to correſpond with what covers the ſtratum of decayed wood at Sutton, by the

* Hiſtory of Embanking and Draining, chap. xxvii.

† Philoſophical Tranſactions, vol. xxii. p. 980.

circum-

circumstances of the roots being (according to Mr. Richardson's observations *) only visible when the water is low, where a channel was cut, which has left them uncovered.

Little doubt can be entertained of the moory islets of Sutton being a part of this extensive and subterraneous stratum, which, by some inroad of the sea, has there been stripped of its covering of soil. The identity of the levels; that of the species of trees; the roots of these affixed, in both, to the soil where they grew; and, above all, the flattened shape of the trunks, branches, and roots found in the islets (which can only be accounted for by the heavy pressure of a superinduced stratum), are sufficient reasons for this opinion.

Such a wide-spread assemblage of vegetable ruins, lying almost in the same level, and that level generally under the common mark of low-water, must naturally strike the observer, and give birth to the following questions:

1. What is the epoch of this destruction?

2. By what agency was it effected?

In answer to these questions, I will venture to submit the following reflections:

The fossil remains of vegetables hitherto dug up in so many parts of the globe, are, on a close inspection, found to belong to two different states of our planet. The parts of vegetation, and their impressions, found in mountains of a cotaceous, schistous, or even sometimes of a calcareous nature, are chiefly of plants now existing between the tropics, which could neither have grown in the latitudes in which they are dug up, nor have been carried and deposited there by any of the acting forces under the present constitution of nature. The formation, indeed, of the very mountains in which they are buried, and the nature and disposition of the materials which compose them, are such as we cannot account for by any actions and re-actions which in the actual state of things take place on the surface of the earth.

* Philosophical Transactions, vol. xix. p. 528.

We muſt neceſſarily recur to that period in the hiſtory of our planet, when the ſurface of the ocean was at leaſt ſo much above its preſent level as to cover even the ſummits of thoſe ſecondary mountains which contain the remains of tropical plants. The changes which theſe vegetables have ſuffered in their ſubſtance is almoſt total; they commonly retain only the external configuration of what they were. Such is the ſtate in which they are found in England by Llwyd; in France by Juſſieu; and in the Netherlands by Burtin; not to mention inſtances in more diſtant countries. Some of the impreſſions or remains of plants found in ſoils of this nature, which were, by the more ancient and enlightened oryctologiſts, ſuppoſed to belong to plants actually growing in temperate and cold climates, ſeem, on accurate inveſtigation, to have been part of exotic vegetables. In fact, whether we ſuppoſe them to have grown near the ſpot where they are found, or to have been carried thither from different parts by the force of an impelling flood, it is equally difficult to conceive how organized beings, which, in order to live, require ſuch a vaſt difference in temperature and in ſeaſons, could live on the ſame ſpot, or how their remains could (from climates ſo widely diſtant) be brought together in the ſame place by one common diſlocating cauſe. To this ancient order of foſſil vegetables belong whatever retains a vegetable ſhape, found in or near coal mines, and (to judge from the places where they have been found) the greater part of the agatized woods. But from the ſpecies and preſent ſtate of the trees, which are the ſubject of this memoir, and from the ſituation and nature of the ſoil in which they are found, it ſeems very clear that they do not belong to the primeval order of vegetable ruins.

The ſecond order of foſſil vegetables, comprehends thoſe which are found in the ſtrata of clay or ſand; materials which are the reſult of ſlow depoſitions of the ſea and of rivers, agents ſtill at work under the preſent conſtitution of

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our planet. These vegetable remains are found in such flat countries as may be considered to be of a new formation. The vegetable organization still subsists, at least in part; and their vegetable substance has suffered a change only in colour, smell, or consistence; alterations which are produced by the development of their oily and bituminous parts, or by their natural progress towards rottenness. Such are the fossil vegetables found in Cornwall by Borlase; in Essex by Derham; in Yorkshire by De la Pryme and Richardson; and in foreign countries by other naturalists. These vegetables are found at different depths, some of them much below the present level of the sea, but in clayey or sandy strata (evidently belonging to modern formation); and have no doubt been carried from their original place, and deposited there by the force of great rivers or currents, as it has been observed with respect to the Mississippi *. In many instances, however, these trees and shrubs are found standing on their roots, and generally in low or marshy places above, or very little below, the level of the sea.

To this last description of fossil vegetables the decayed trees here described certainly belong. They have not been transported by currents or rivers; but, though standing in their native soil, we cannot suppose the level in which they are found to be the same as that in which they grew. It would be impossible for any of these trees or shrubs to vegetate so near the sea, and below the common level of its water; the waves would cover such tracts of land, and hinder any vegetation. We cannot conceive that the surface of the ocean has ever been lower than it now is; on the contrary, we are led, by numberless phenomena, to believe that the level of the water in our globe is now below what it was in former periods: we must therefore conclude, that the forest here described grew in a level high enough to permit its vegetation; and that the force (whatever it was)

* Le Coudriniere sur les Depôts du Missisippi, Journal de Physique, vol. xxi. p. 230.

which destroyed it, lowered the level of the ground where it stood.

There is a force of subsidence (particularly in soft ground), which, being a natural consequence of gravity slowly though perpetually operating, has its action sometimes quickened and rendered sudden by extraneous causes, for instance by earthquakes. The slow effects of this force of subsidence have been accurately remarked in many places: examples also of its sudden action are recorded in almost every history of great earthquakes. The shores of Alexandria, according to Dolomieu's observations, are a foot lower than they were in the time of the Ptolemies. Donati, in his Natural History of the Adriatic, has remarked, seemingly with great accuracy, the effects of this subsidence at Venice; at Pola in Istria; at Lifs, Bua, Zara, and Dielo, on the coast of Dalmatia. In England, Borlase has given, in the Philosophical Transactions*, a curious observation of a subsidence, of at least sixteen feet, in the ground between Sampson and Trescaw islands in Scilly. The soft and low grounds between the towns of Thorne and Gowle in Yorkshire, a space of many miles, has so much subsided in latter times, that some old men of Thorne affirmed, "that whereas they could before see little of the steeples (of Gowle), they now see the church-yard wall †." The instances of similar subsidence, which might be mentioned, are innumerable.

The force of subsidence, suddenly acting by means of some earthquake, seems to me the most probable cause to which the usual submarine situation of the forest we are speaking of may be ascribed. It affords a simple, easy explanation of the matter; its probability is supported by numberless instances of similar events; and it is not liable to the strong objections which exist against the hypothesis of the alternate depression and elevation of the level of the ocean; an opinion which, to be credible, requires the support of a great number

* Vol. XLVIII. p. 62. † Gough's Camden.

ber of proofs less equivocal than those which have hitherto been urged in its favour, even by the genius of a Lavoisier*.

The stratum of soil, sixteen feet thick, placed above the decayed trees, seems to remove the epoch of their sinking and destruction, far beyond the reach of any historical knowledge. In Cæsar's time, the level of the North Sea appears to have been the same as in our days. He mentions the separation of the Wahal branch of the Rhine, and its junction to the Meuse; noticing the then existing distance from that junction to the sea, which agrees, according to D'Anville's inquiries†, with the actual distance. Some of the Roman roads, constructed, according to the order of Augustus, under Agrippa's administration, leading to the maritime town of Belgium, still exist, and reach the present shore‡. The description which Roman authors have left us, of the coasts, ports, and mouth of rivers on both sides of the north sea, agree in general with their present state; except in the places ravaged by the inroads of this sea, more apt, from its force, to destroy the surrounding countries than to increase them.

An exact resemblance exists between Maritime Flanders and the opposite coast of England, both in point of elevation above the sea, and of the internal structure and arrangement of the soils. On both sides, strata of clay, silt, and sand, (often mixed with decayed vegetables), are found near the surface; and, in both, these superior materials cover a very deep stratum of blueish or dark-coloured clay, unmixed with extraneous bodies. On both sides they are the lowermost part of the soil, existing between two ridges of high lands‖, on

* Mem. de la l'Acad. de Paris, 1789, p. 351.

† Notices des Gaules, p. 461.

‡ Nicholas Bergier, Hist. des Grands Chemins des Romains, Ed. de Bruxelles, vol. II. p. 101.

‖ These ridges of high land, both on the British and the Belgic side, must be very similar to each other, since they both contain parts of tropical plants in a fossil state. Cocoa-nuts and fruits of the Areca are found on

on their refpective fides of the fame narrow fea. Thefe two countries are certainly coeval; and whatever proves that Maritime Flanders has been for many ages out of the fea, muft, in my opinion, prove alfo that the foreft we are fpeaking of was long before that time deftroyed and buried under a ftratum of foil. Now it feems proved from hiftorical records, carefully collected by feveral learned members of the Bruffels Academy, that no material change has happened to the lowermoft part of Maritime Flanders during the period of the laft two thoufand years *.

I am therefore inclined to fuppofe the original cataftrophe which buried this foreft to be of very ancient date; but I fufpect the inroad of the fea, which uncovered the decayed trees of the iflands of Sutton, to be comparatively recent. The ftate of the leaves and of the timber, and alfo the tradition of the neighbouring people, concur to ftrengthen this fufpicion. Leaves, and other delicate parts of plants, though they may be long preferved in a fubterraneous fituation, cannot remain uninjured when expofed to the action of the waves and of the air. The people of the country believe that their parifh-church once ftood on the fpot where the iflets now are, and was fubmerged by the inroads of the fea, and that at low water their anceftors could even difcover its ruins; that their prefent church was built to fupply the place of that which the waves wafhed away, and that even their prefent clock belonged to the old church. So many concomitant circumftances, though weak teftimonies, incline me to believe their report; and to fuppofe that fome of the ftormy inundations of the North Sea, which in thefe laft centuries have wafhed away fuch large tracts of land on its fhores, took away a foil refting on clay, and at laft uncovered the trees which are the fubject of this paper.

the Belgic ridge. The petrified fruits of Sheppey, and other impreffions of tropical plants on this fide of the water, are well known.

* Vide feveral papers in the Bruffels Memoirs; alfo *Journ. Phyf.* Vol. XXXIV. p. 48.

XIII. *On*

XIII. *On an Epidemical Disease among Cats.* *By* J. F. Blumenbach *.

THE disease among the cats, which prevailed lately in Denmark and various other countries of Europe, and which in Lombardy destroyed a great many of these useful animals, induced the Council of Health at Pavia to make an inquiry into the nature of it, and to cause the result to be published by one of their members, Professor Brera, in a small but interesting pamphlet under the title of *Memeria sull' attuale Epidemia de' Gatti* †.

The cats attacked by this disease seemed dejected and weak, and had an aversion to approach man; crawled about as if under great oppression; would neither eat nor drink; and could not endure any of the three plants of which they are commonly so fond, *Marum verum*, Valerian, and Cat's mint. In the course of the disease the weakness and dullness increased; they could scarcely support themselves on their legs; their hair stood erect; they let their tail hang down, and their head droop so that their neck appeared as if prolonged; their ears were flabby and cold; the eyes seemed smaller, and the pupil contracted; the tongue was dry, and covered with yellow slime; they discharged from the mouth a whitish green foam, were for the most part costive, breathed short, and had a quick feverish pulse, accompanied with burning heat. They at length became like mere skeletons, were seized with violent convulsions, and generally died on the fourth or fifth day of the disease; which, according to the symptoms, was a nervous fever, accompanied with dejection. It is, however, far from being always mortal; and many of the animals attacked by it recovered again gradually, without any assistance.

* From *Voigt's Magazin für der neuesten zustande der Naturkunde*, Vol. I. Part 3.

† It was published at Pavia last year (1798), and consists of twenty-six pages quarto.

The

The method in which this difeafe was treated was entirely Brownonian; that is, half an ounce of Cyprus wine, with a fcruple of pulverifed valerian root, was given four times a day to the difeafed animals: aloes, and the juice of garlic, were adminiftered in fome fpiritous vehicle, and alfo fumigations with vinegar. The propofal for deftroying every cat attacked by this difeafe was, with great propriety, rejected; but it was at the fame time ordered, that thofe which died of it fhould be buried at a fufficient depth in the earth; that the bodies fhould be covered with lime; and that the places where they were found dead fhould be wafhed with vinegar, ley of wood-afhes, or lime-water. It was recommended alfo to feparate, as much as poffible, found animals from thofe infected; to give them nourifhing food; to lay before them, in particular, their three favourite plants; and to fumigate them often with the fteam of vinegar.

That excellent phyfician and naturalift Profeffor Schacht, of Harderwyk, informed me, by a letter dated in May 1796, that the cats in his neighbourhood had for fome weeks been attacked by a difeafe which bore fome refemblance to a prurient eruption. The violent itching occafioned a defluxion of the eyes, which continually watered, and they at length became blind; their teeth at the fame time dropped out, and they died foon after with lamentable cries. It had been obferved in the preceding months, from February to April, that their cries in the night-time, on account of their pairing, had been extraordinarily ftrong and loud.

Dr. Darwin, in his *Zoonomia* *, mentions another epidemia which prevails at times among the cats, and which he calls *Parotidis felina*. It announces itfelf by a violent fever with inflammation, and abundant fuppuration in the region of the falival glands beneath the lower jaw. He compares it to a difeafe lately known called the Mumps (*Angina parotidea*), and is inclined to believe that it was firft communicated to cats by infection from the human race. He men-

* Vol. II. p. 229.

tions alſo a diſeaſe which affects the neck and head of cats, by which the greater part of theſe animals in Weſtphalia died; and refers to a paſſage in Sauvage's *Noſologia* *, which however, in an extract of that work in three large volumes octavo †, now before me, I have not been able to find.

XIV. *On the Preparation of Crayons uſed for Drawing, from the Paſte of Reddle.* By C. F. LOMET ‡.

IN moſt drawing-ſchools, and particularly thoſe at a diſtance from the capital, many difficulties are experienced for want of good crayons. Thoſe ſawed from red chalk, which are in common uſe, are almoſt always hard, gritty, and often of an unequal conſiſtency; ſo that the touches in the drawings for which they are uſed can never have the ſtrength or correctneſs neceſſary to produce the deſired effect. The only good crayons uſed in France are manufactured excluſively at Paris, where they are ſold very dear: the beſt ſort have been long known by the name of the paſte-crayons of *Deſmarets*, who apparently was the inventor. As no author who has written on the compoſition of theſe crayons has pointed out the proportions of the ingredients neceſſary to be uſed, I made many trials with every combination of the ſubſtances that appeared to me proper for making them. I rejected thoſe products which did not anſwer the objects of my reſearch; and I here ſubjoin thoſe mixtures that gave me ſatisfactory reſults.

Theſe pencils are compoſed of the ſofter kind of reddle, which is an oxyde of iron mixed with earth of an argillaceous nature, and called *hematites*, or bog-ore. It muſt be incorporated with ſome agglutinating ſubſtance, ſuch as gum, ſize, or reſin; to which ſometimes ſoap is added, to

* Noſol. cl. X. art. 30. 8.

† Amſt. 1763.

‡ From the *Annales de Chimie*, No. 90. an. 7.

ſoften

ſoften the compoſition. Inſtead of reddle the other red oxydes of iron may be uſed, ſuch as colcothar of vitriol, &c.; and in that caſe they ſhould be choſen ſoft to the touch, and of a lively colour: for thoſe uſed in commerce are often mixed with too much clay, which gives them a dull yellowiſh caſt that ought to be avoided. I attempted to incorporate theſe ſubſtances with the whites of eggs and the albumen of blood; but crayons compoſed in this manner were not good.

The beſt reddle, in lumps, ſhould be ſelected and ground with pure water on a marble ſlab, as is done in the preparation of colours for painting; taking care to moiſten it as much as is neceſſary to make the grinding ſtone glide, and to employ as little water as poſſible. When it is intended to prepare a large quantity of this ſubſtance, this operation becomes very difficult and expenſive: in that caſe a different method muſt be uſed. The reddle muſt be pounded and ſifted through a fine ſieve, then diluted with a large quantity of water in a trough; where, after it has been well ſtirred round, it ſhould be left a few minutes to ſettle, in order that the groſſer particles may precipitate themſelves to the bottom. The water, which is ſtrongly impregnated with the finer particles, is then poured off, and ſuffered to ſettle for twenty-four hours. The clear water on the top is then poured off again, and a very fine ſediment will thus be obtained, which muſt be pounded and waſhed once more. The ſediment of the firſt waſhing muſt be treated in the like manner, and the proceſs is repeated until the whole be reduced to the utmoſt fineneſs.

The gum, ſize, or ſoap, deſtined to give the crayon the neceſſary degree of ſolidity, muſt be diſſolved ſeparately. Theſe ſolutions muſt be carefully mixed with the pounded reddle, and the watery particles muſt be evaporated by being expoſed to the ſun or to the heat of a gentle fire, taking care to turn the paſte often till it has acquired a conſiſtence ſomewhat harder than butter: the crayons are then to be formed in the moulds.

The

The moulding may be performed two ways: the firſt is, to ſpread out the paſte on a board, in which are cut grooves rather broader at the top and round at bottom; and of any length, ſize, and depth, proportioned to the intended ſize of the crayons. The ſecond, which is the better method, is to force the paſte through a pipe or funnel of an orifice equal to the ſize of the crayon. The paſte thus formed may be left to dry ſlowly in a cool place under the ſhade, in order to prevent cracks, which too haſty deſiccation might produce. When the rods are dry, they are to be cut into pieces of the deſired length: the edges muſt then be taken off; after which they muſt receive the firſt cutting, to give them a blunt point. The laſt operation is to ſcrape them, in order to take off the hard outward coat formed on the ſurface while they are drying, and which would prevent them from making any marks. It may be neceſſary to rub a ſmall portion of oil into the grooves of the wood, that the paſte may not adhere too cloſely to the moulds.

Gum arabic and iſinglaſs are the two ſubſtances to be preferred for mixing with the powder. It will be ſufficient to diſſolve the gum and ſoap in cold water; but the iſinglaſs muſt firſt be cut into ſmall pieces, then put into hot water, and diſſolved in *balneo mariæ*. Theſe ſolutions ſhould be well diluted with water, that they may be made to paſs through a hair ſieve in order to remove any foreign particles. As it is difficult to incorporate the paſte with the iſinglaſs, they muſt both be heated and mixed over a fire with a heat equal to that of boiling water. The paſte muſt be well mixed before it is moulded, in order that it may be uniformly incorporated with the ſolution, and that there may not remain any hard lumps. The beſt way would be to beat it with a peſtle or mallet, and to pound it again for ſome time before it is put into the moulds.

No ſoap muſt be employed but for thoſe crayons in which gum is uſed. In all the trials I have made with iſinglaſs and

ſoap,

ſoap, not one of them ſucceeded: and it muſt neceſſarily be ſo; for, the exceſs of alkali in the ſoap, operating on the gelatinous matter, deſtroys its agglutinating quality. As the crayons for which ſoap has been uſed are of a browner caſt, it would appear that this combination abſtracts the oxygen from a part of the red oxyde of iron, and gives it a brown tint by making it approach the ſtate of martial æthiops. I have remarked, that all the paſtes prepared with oxyde of iron, even when pure water alone is uſed, grow brown on the exterior ſurface as they dry: this takes place in a more ſenſible manner when they are expoſed to the action of the ſun; which ſeems to ariſe from the light abſtracting a portion of oxygen from the oxyde of iron. At ſome future period I ſhall enter into a farther inquiry reſpecting the chemical properties of theſe preparations; but at preſent I ſhall content myſelf with pointing out the proceſſes which have conſtantly ſucceeded with me, and in ſuch a way that they may be put in practice any where with ſucceſs.

The crayons compoſed in this manner have every good property that can be deſired; they do not coſt one quarter the common price: but it muſt be obſerved, that their compoſition requires great nicety in regard to the quantity of the materials, becauſe the leaſt variation occaſions conſiderable difference in the quality of the paſte. Particular care muſt alſo be taken to guard againſt the errors that may ariſe from the waſte, which is unavoidable during the courſe of the operation. The beſt means to prevent it will be, to fix by experiments the quantity of water and of ingredients which the pounded reddle and the ſolutions form before the mixtures are made. By means of the following tables, which exhibit the quantity of ingredients to be uſed for the different kinds of crayons, it will be eaſy to know what proportion of gum, iſinglaſs, or ſoap, muſt be employed for a determined quantity of reddle, or red oxyde of iron.

Indication

Indication of the Substances to be used, their Quantities, and what they will produce.

I. Dry reddle, or red oxyde of iron, 1 ounce; gum arabic, dry, 18 grains.—These crayons are very tender, but they may be employed for large designs. As they are the kind in which the least gum is used, they have not sufficient consistence for any other purpose.

II. Reddle, &c. 1 ounce; gum 21 grains.—Strong crayons, a little tender, but excellent for large drawings.

III. Reddle 1 ounce, gum 24 grains, or rather $25\frac{1}{2}$ grains. —Soft and solid crayons: they are the best that can be employed for common use.

IV. Reddle 1 ounce, gum 27 grains.—Crayons rather firm, but not hard; useful for drawings that require delicacy.

V. Reddle 1 ounce, gum 30 grains.—Very firm crayons, proper for drawings in which every stroke is intended to be given.

VI. Reddle 1 ounce, gum 33 grains.—Very hard crayons, which cannot be used without some force. The largest quantity of gum that can be employed is used in their composition: with more they would be useless.

VII. Reddle 1 ounce, gum 22 grains, white hard soap 30 grains.—These crayons have a little browner cast than the former; they are of a very good consistence, and can be easily cut. All crayons, however, in the composition of which soap is employed, are attended with this fault, that the strokes they make have a shining appearance if the touches are repeated a little too strongly. No other experiment with soap succeeded. These crayons have a perfect resemblance to those made by Desmarets.

VIII. Reddle 1 ounce, isinglass 36 grains.—Crayons of a brilliant colour, and excellent for use. If less isinglass is employed they become brittle; and if more, they are too hard.

XV. *Descrip-*

XV. *Deſcription of* HUMBOLT's *New Portable Barometer**.

TO have a barometer compoſed of ſeveral parts which could be eaſily put together, and which ſhould correct itſelf at each obſervation like an aſtronomical inſtrument, were the reaſons which induced M. Humbolt to deviſe the preſent conſtruction. Tralles, the learned aſtronomer of Berne, has judiciouſly obſerved, that all barometers are liable to be broken when the tube is fixed to the ſcale which belongs to it. In Humbolt's barometer the tube is diſtinct from the ſcale; and when the tube breaks, its place can be ſupplied by another even on the top of a mountain. The tube, the lower part of which is repreſented by *abc* (fig. 1. pl. VII.) is cemented into an iron one *bc*, two inches long, terminating in a nut *c*, which receives a ſcrew to the depth of $2\frac{1}{2}$ lines: the end of the ſcrew is ſquare. When the tube is filled with mercury, and ſcrewed cloſe, it is put into a tube of copper lined with flannel, and covered on the outſide with leather. This caſe may be carried as a cane; the head *d* of the ſcrew being kept, as far as poſſible, in a vertical poſition. If the entrance of air be apprehended, it will lodge itſelf under *d*. In that caſe turn the ſcrew and pour a drop of mercury upon it before it is ſhut. The whole tube may be examined to ſee that the mercury is not ſeparated by air bubbles; an advantage wanting in the Engliſh barometers, in which the tubes are half concealed. The mahogany pillar *cgf* (fig. 2.) contains the mercury, to be poured into it after it has been ſcrewed into its ſtand *gh* (fig. 3.), ſupported by three feet that fold over each other. The interior part of the column forms a hollow parallelopipedon, the ſquare aperture of which is exactly equal in ſize to the ſquare of the ſcrew *cd*. In puſhing the tube *klma* (fig. 4.) into this aperture until *cd* be above the level of the mercury, you turn the tube to the right, by laying hold of it with one hand between *lm*.

* From the *Journal de Phyſique*, an. 7.

As

As the fquare *cd* cannot then turn, being held faft in the pillar, the fcrew is loofened, *cd* finks down floating on the mercury, and the atmofpheric air has free communication with the mercury in the tube. The Torricellian vacuum is formed under *k*, and the mafs of mercury in the column is increafed. The fcale *no* (fig. 4.) is attached to a wooden rod *nop*, formed of two pieces of timber of a different kind, and fcrewed at *p* and *q* to the mahogany pillar. Turn the three fcrews *rrr* until the vertical pofition of the inftrument is announced by the plummet *s*. If you fix the fcale to the tube *ka*, by fcrewing clofe the fcrews *l* and *m*, there will be too much mercury in the pillar. The point *o* of the barometer is placed in the aperture of the cock *s*, and you will have a *conftant level* by opening that cock and fuffering the mercury, which you muft collect in a fmall vafe, to flow down. In order that the ivory cock *s* may not open of itfelf, there is, at *t*, a fork which by a fcrew can be fixed in each pofition to prevent it. When the obfervation is made, you place in *ge* a fmall cufhion, or covering, held by two fcrews *vv*, which prevent the efcape of the mercury while you are walking; or you difmount the inftrument by again pufhing the tube *klm* (unfcrewed at *m* and *l*) to the bottom of the pillar *f*, where you turn the fquare *cd*. The Torricellian vacuum is by thefe means filled, and you turn the tube to the left, holding it with your hand between *l* and *m* until you obferve that *cd* has caught, and that the aperture of the tube is clofed. You then draw out the tube with *cd* well fhut in order to inclofe it in its cafe. There is a lofs of a few drops of mercury which adhere to the iron. One of thefe inftruments, conftructed two years ago, has remained unhurt during a great many journies over the moft rugged roads and the fteepeft mountains. More time is required to make an obfervation with it than with a common barometer; but it is the only one perhaps which could with certainty be ufed, were it to become deranged even in the deferts of Thibet.

Theſe inſtruments are now made at Berlin, Weimar, Dreſden, Vienna, and Paris. On coming from a cold to a very warm temperature the ſcrew *cd* muſt be looſed before you approach the fire. This inſtrument has an advantage by which it is diſtinguiſhed from all others: it is the only one in which the ſize of the Torricellian vacuum depends on the obſerver: the height of the mercury remains the ſame to whatever depth it be plunged in the mercury, provided you take care each time to adjuſt the level by the cock. Muſcati has proved, that the barometric height is affected by the ſize of the vacuum on account of the attraction of the glaſs in *k*, and becauſe the *minimum* of air which the vacuum contains is more or leſs dilated. In Humbolt's barometer, the ſame Torricellian vacuum exiſts on the tops of the mountains as in the valleys.

The different pieces of which this inſtrument conſiſts are contained in one cylinder, which may be carried on the ſhoulder like a fuzee. Several tubes may be contained alſo in a walking-ſtick. Having for two years meaſured the height of different mountains with Humbolt's barometer, and others conſtructed on the old principles, no ſenſible differences were obſerved, though this operation, for various reaſons explained by Tremblay, is ſtill very far from perfection.

XVI. *Poſtſcript to Volta's Letters on Animal Electricity* *.

SOME new facts, lately diſcovered, ſeem to ſhew that the immediate cauſe which excites the electric fluid, and puts it in motion, whether it be an attractive or a repulſive power, is to be aſcribed much rather to the mutual contact of two different metals, than to their contact with moiſt conductors. But, though it cannot be denied that in the latter caſe there exiſts an action, it is proved that it exerts itſelf in a far more

* See page 59 and 163.

conſider-

confiderable degree when the two metals mutually touch each other. There arifes by the mutual contact, for example, of filver and tin, an action or power by which the former communicates the electric fluid, and the latter receives it; or the filver fuffers it to efcape, and the tin attracts it. This produces, when the circle is rendered complete by moift conductors, a ftream, or continual circulation of the fluid. When the circle is complete, there is an accumulation in the tin at the expence of the filver; which indeed is very fmall, and far under the point neceffary to enable it to announce itfelf by the moft delicate electrometer. I have however been able, by the affiftance of my condenfer, conftructed on a new plan, and ftill better by Nicholfon's Doubler, to render it very perceptible: I fhall here communicate the refult obtained by my experiments, which I made fome time ago with great fatisfaction.

EXPER. I. The three plates of the doubler are of brafs. I took two ftrong wires, one of filver and the other of tin, and brought the former into contact with the moveable plate, and the other with one of the fixed plates; while they both refted on the table, or, what is better, on moift pafteboard, or any other moift conductor, fo as to be in communication by the intervention of one or more conductors of the fecond clafs. I fuffered the apparatus to remain fome hours in this ftate, then removed the two wires, and put the machine in motion. After 20, 30, or 40 revolutions, (or more when the atmofphere was not dry, or the infulation imperfect,) I brought one of my ftraw electrometers into contact with the moveable plate, and obferved indications of pofitive electricity (+E) which arofe to 4, 6, 10 degrees, and more. If I fuffered it to touch the fixed plates, I had the correfponding indications of the oppofite kind of electricity (−E).

The filver, therefore, poured the elaftic fluid into the brafs plate when it had been fome time in contact with it; and the tin attracted it from the other plate, which was alfo of

brass, while in contact with it. This was confirmed by the following experiment, which is a real *experimentum crucis.*

II. I reversed the experiment, so that the silver was in contact with one of the fixed plates, and the tin with the moveable one. The electricity which I obtained from the latter, after the apparatus had remained a sufficient time in that position, was negative (−E); while that of the fixed plate was positive (+E).

III. I applied only the tin wire to the moveable plate, and insulated the two fixed ones, or brought them into communication with the table or any other moist conductors with which the tin wire was in contact. This simple contact of the tin with the brass, of which the moveable plate consists, is sufficient to excite in it a very small degree of negative electricity; only a longer time is required.

Those acquainted with the action of electric atmospheres, and the construction of the doubler, will need no farther explanation to enable them to comprehend the mode of action of this very ingenious instrument; how the electricity, once obtained from the moveable plate, must occasion an opposite kind in the fixed plates, and *vice versa*; how the opposite kinds of electricity are increased by each revolution of the machine, &c. In the present experiment, therefore, when the moveable plate is −E, the fixed plate must be +E.

III. This is the reverse of the former. The piece of tin was applied to one of the fixed plates, and the moveable one was insulated from all metallic contact. The result was now reversed; that is, the fixed plates were electrified negatively, and the moveable one had positive electricity.

All these experiments succeed much better, and in a shorter time, if, during the mutual contact of the different metals, the moveable plate be opposite to either of the other two that are fixed; but still better when a piece of thick paper, such as a card, not moist, and of a thickness equal to the intermediate space, is placed between the two plates that stand opposite to each other. It is of advantage to leave the card

some

ſome time in its place, and not to remove it till the moment when the metals in contact are removed and the machine put in motion. To render the inſulation complete, and make the contact of the metals immediate, without the leaſt moiſture, which would be highly prejudicial, it will be proper to place the apparatus in the ſun. Half an hour, and often leſs, will then be ſufficient to obtain the required electricity, &c.; whereas, in other caſes, ſeveral hours are neceſſary before the deſired reſult can be obtained. A repreſentation of this experiment is exhibited by fig. 21, 22, 23 and 24, (Plate I.) L L L (fig. 21 and 22) are the three braſs plates of the doubler; A the piece of ſilver which is in contact with one of theſe plates; E the piece of tin applied to the other plate, which is oppoſite to the former; *a a* the moiſt conductor, or chain of moiſt conductors which form a communication with the pieces of metal. When the ſilver, as in fig. 21, is in contact with the anterior moveable plate, it gives up to it a little of the electric fluid, and the latter accumulates as much of it as poſſible; conſequently the electricity of the plate becomes poſitive, as the ſign + of the plate ſhews: whereas the tin attracts the electric fluid from the correſponding fixed plate, which by theſe means has negative electricity, as the ſign (—) of the plate indicates; and it even communicates this electricity to the other fixed plate, which therefore has the ſign (—) alſo.

In fig. 22, every thing is reverſed: the moveable plate is negatively electrified (– E), while the two fixed plates become poſitive (+ E).

Laſtly, in the 23d and 24th figure, it is ſeen, that the tin abſtracts the electric fluid from the braſs plate with which it is in contact. This plate is therefore negatively electrified, or has — E; and by the action of its atmoſphere occaſions poſitive electricity (+ E) in the other plate ſtanding oppoſite, which is in communication, either with the third plate, as fig. 23, or, what is ſtill better, with other conductors, as fig. 24. Theſe oppoſite electricities increaſe af-

terwards with each revolution of the machine; the action of which, according to the theory of electric atmospheres, produces this effect to the degree mentioned, and justifies the appellation of doubler of electricity, which has been given to this instrument.

I now come to the experiments, which show that we are to seek for the cause which calls forth the action of the electric fluid; which excites it, of whatever kind it be; determines its transition, &c. much rather in the mutual contact of the metals, than in the contact of the moist conductors with these metals. Though, according to every circumstance, we must admit some action of this kind in the latter contact, it cannot be denied that the former is certainly the most effectual. At present I shall only mention the two following experiments, which I contrived in such a manner that they may serve to explain a question of this kind.

V. I left the two fixed plates of brass without making any alteration; took off the third moveable plate, and supplied its place by one of tin; and arranged the machine in such a manner that the latter stood opposite to one of the other two plates. I then applied to this tin plate a bit of brass, and to the opposite fixed plate of brass a piece of tin. After a convenient time, (for example an hour, when the weather was perfectly dry,) I took away the two pieces of metal, or only that of brass, and made the moveable plate of tin, which was in contact with the piece of brass, to revolve about thirty times. It then gave me very perceptible marks of positive electricity.

VI. I reversed the former experiment, and made the piece of brass touch the brass plate, and the piece of tin the plate of the same metal. I, however, obtained nothing, or almost nothing; even when the apparatus was left a much longer time in that situation, and when the machine had made twice or three times as many revolutions.

These two experiments are represented by fig. 25 and 26: where L is the piece of brass; E that of tin; and *a a* the moist

moift conductors which connect the two different pieces of metal.

In the arrangement of fig. 26, the fame contact of different metals, viz. brafs on the one fide, and tin on the other, with the fame kind of moift conductor, takes place, as well as in the preceding experiment of fig. 25. The addition of the electric fluid in the one, and the abitraction of it in the other, ought therefore equally to take place, though in an inverted order, when the action on the fluid calls forth the moving power, by this contact of the two metals L, E, with the moift conductor between them; and yet this is not the cafe, as no figns of electricity are obtained even after a long time, and when the machine has been caufed to make twice or three times as many revolutions. The condition effentially neceffary to obtain electricity is, that the different metals muft be in contact with each other, which is the cafe in fig. 25, but not in fig. 26.

When the machine has been repeatedly turned, fomething may be obtained. This arifes either from fome fmall remains of old electricity, which could not be deftroyed or diffipated in the time duringw hich the arrangement of fig. 26 was continued; or even from frefh electricity, which the moveable plate may have obtained from the atmofphere or vapours during the pretty confiderable time of the machine being in a ftate of revolution; or fome accidental difference, either between the two tin or the two brafs pieces, may be the caufe of fome action on the electric fluid, or of fome derangement in regard to the equilibrium. In the laft place, the contact of the moift conductor with the tin on the one fide, or with the brafs on the other, may have a different action, which, in my opinion, muft be very fmall, but yet is not entirely without effect.

As it is now proved that, according to the arrangement of the fixth experiment, nothing, or almoft nothing, is obtained by 40, 60, and even 80 revolutions of the doubler, while a great deal is obtained by that of the fifth with 20

 or

or 30, we muft therefore conclude that the contact of two metals of a different kind with moift conductors, without the mutual contact of thefe metals themfelves, (which is wanting in the fixth experiment, where brafs is in contact with brafs, and tin with tin,) produces nothing or almoft nothing; and that, on the contrary, the mutual contact of the two metals of a different kind, which takes place in the fifth experiment, produces the whole, or almoft the whole, effect.

XVII. *A Statement of the Progrefs in the* Vaccine Inoculation; *and Experiments to determine fome important Facts belonging to the Vaccine Difeafe. By* George Pearson, M.D. F.R.S. *Phyfician to St. George's Hofpital,* &c.

THE collection of teftimonies which I publifhed, in November laft, in my *Inquiry concerning the Hiftory of the Cow-pox*; and the Circular Letter, which I iffued in March, ftating the progrefs of the *Vaccine Inoculation*, and containing thread impregnated with *matter*, have procured me much information. In particular, through the recommendation of the *Surgeon-general, Thomas Keate, Efq.* the new practice has been introduced into the army; of which a valuable report has been already communicated. I have been alfo fo fortunate as to obtain permiffion to practife the *new inoculation* in certain fituations where great numbers would have been inoculated for the fmall-pox. The cafes from thefe fources, and a pretty large ftock from private practice, form a valuable body of evidence, by means of which the profeffional public will be enabled to eftimate (I do not fay precifely) the value of the *new practice*; and alfo anfwer many of the queries, and fupply fome of the deficient parts of the hiftory of the vaccine difeafe, which were ftated in the *Inquiry* above mentioned. But fuch are my occupations at prefent, and in all likelihood fuch they will be for a confiderable time, that I cannot at this time arrange, for the ufe of the

the public, the valuable materials tranſmitted to me. It will, however, perhaps be not without utility at this time firſt to ſtate a few general reſults from the vaccine inoculation; and ſecondly, to relate ſome *trials*, from which I apprehend concluſions can warrantably be drawn to promote the inveſtigation now going forward.

Not much more than ſix months have elapſed ſince the opportunity was afforded, by the breaking out of the *vaccine diſeaſe* in two principal milch farms near London, of obtaining matter for propagating the ſame diſeaſe among human creatures. The *new inoculation* was immediately introduced in London, and ſoon afterwards in the neighbourhood, as well as in many provincial ſituations. It is with ſincere ſatisfaction that we can now reckon, at the feweſt, 2000 perſons who have paſſed through the cow-pox by inoculation. But in this number I include the very large proportion furniſhed by him who, ſo beneficially to the public, and honourably to himſelf, poſſeſſes the office of phyſician to the Small-pox Hoſpital. From the above experience we receive, as I expected, important information.

1. Of the above number it appears that *one* patient died; (Woodville's Reports, p. 151.) and to avoid controverſy, let us allow that the death was occaſioned ſolely by the inoculation. Now, according to the juſteſt calculation I have been able to make, as in the inoculated ſmall-pox one in 200 * dies from the diſeaſe, it is evident, in the preſent ſtate of

* I am fully aware that ſo great a proportion as one in 200 will not be allowed by many practitioners. And to perſons who have been told, and believe, that inoculation for the ſmall-pox "ſcarcely ever does any harm"—that certain practitioners have inoculated many thouſands without loſing a patient—that others have told their friends "they never had a fatal inoculated caſe in their whole lives"—I ſay to ſuch perſons, no advantage, on the ſcore of ſaving life, will be allowed from the cow-pox. But I have converſed with many candid and experienced practitioners, and they are well ſatisfied that I am warranted in the above ſtatement of deaths in the inoculated variola. I beg leave to ſay farther, that I believe more perſons

of the practice, that the proportion of fatal cafes in the inoculated fmall-pox, to the inoculated cow-pox, is as 10 to 1.

2. The conftitutional affection, or fever, which occurs in the cow-pox about the 9th day after inoculation, is much more confiderable in many cafes than was apprehended from the firft account by Dr. Jenner, although in a great proportion of cafes it is extremely flight, and in many cannot be obferved at all. But I muft correct my ftatement in March laft, in which I faid, "Although the extreme cafes of the fevere kind, which ordinarily occur in the fame number of cafes in the inoculated fmall-pox, did not occur in the new practice, and although many of the patients were even more flightly difordered conftitutionally, yet the whole amount of the conftitutional illnefs feemed to be as great as in the fame number of patients in the inoculated fmall-pox." Since that report, or at leaft for the laft four months, as far as I have obferved and been able to learn from others, the whole amount of the conftitutional illnefs was not one half of the whole amount in an equal number of patients inoculated for the fmall-pox. Now, whether the greater mildnefs of the difeafe depended on the different ftate of the human conftitution in the fummer from that of winter, as feems to me moft probable; or that it depended on the difference in the ftate of the vaccine matter, muft be determined by future experience in the fame feafons.

3. The moft remarkable difference in the practice of the laft winter, and prefent fummer, has been with regard to the eruptions which fo often occurred, efpecially in the Small-pox Hofpital; which eruptions, in many inftances, could not

fons in proportion have died of the inoculated fmall-pox within a few years, than died in the fame time 20 years ago. And this may be accounted for from the unwarrantable affertions of many inoculators, from whom a great part of the public have imbibed the opinion, that the inoculated fmall-pox was never attended with any danger; hence the practice is often trufted in the hands of perfons not fufficiently acquainted with the treatment fit for different ftates of the human conftitution.

be

be distinguished from those of the small-pox, and which were wholly unexpected from the original description by Dr. Jenner. No explanation hitherto given consists with the observations relative to these eruptive cases: but the facts are as Dr. Woodville states (Med. Mag.), that they have occurred much less frequently this summer than in the spring and winter preceding. In my private practice, not a single case with eruptions resembling the small-pox has occurred these last four months, and but a small proportion with any eruptions of other kinds. From my correspondents I have not had a single case of eruptions like the variolous since that of Dr. Redfearne's of Lynn; not one of this sort in Mr. Kelson's, of Seven Oaks, report of about 100 patients; not one in Dr. Mitchell's, of Chatham, of about 50 patients; not one in the report of near 100 patients from Dr. Harrison of Horncastle, communicated to the Rt. Hon. Sir Joseph Banks; and, in short, not one case with these eruptions appears in the accounts from my other correspondents.

4. The arms have manifested, in many instances, a much more extensively spreading red areola around the inoculated part than is usual in the small-pox; which redness sometimes extended over the greater part of the whole arm. This appearance is very alarming to both the patient and the inexperienced practitioner; but no danger seems to be attendant on such a state of the parts, for it disappears in at most two or three days, by no means gives pain in proportion to its appearance, and, in the cases I have seen, affects the constitution very little. I would rather call this spreading redness of the skin *erythema* than erysipelas. As to phagedenic ulcers, as they have been called, ensuing from the inoculated part, many sore arms have been produced; but nine out of ten were occasioned, or at least much aggravated, by the tightness of the clothes; by allowing the linen to stick to the sore; by scratching the pustule; and sometimes by emollient poultices. The experience we have had, then, since January last, in London and in the country, does not agree exactly

actly with Dr. Jenner's account concerning the ſtate of the arms: he thinks ſome new applications of a cauſtic nature neceſſary, in many caſes, to prevent ſecondary ſymptoms from the ſores; but in Dr. Woodville's Report, p. 155, my correſpondents, and my own practice, there has not been found any want of applications for ſuch a purpoſe.

5. Concerning the important point of the certainty of the action of the cow-pox on the human conſtitution in producing unſuſceptibility of taking ſubſequently the ſmall-pox; I can only at preſent ſay, that I have inoculated many ſcores with ſmall-pox matter after the vaccine diſeaſe, and never with the effect of exciting the ſmall-pox. But I have had accounts ſent to me, not of people taking the ſmall-pox after the inoculated cow-pox, but of theſe taking the ſmall-pox after the cow-pox in the caſual way. I have, indeed, been deſired to ſee even ſome of my own patients who, I was acquainted, had taken the ſmall-pox after the cow-pox; but theſe caſes turned out to be either thoſe in which the cow-pox had not in reality preceded, or they were caſes of merely local affection from the inoculated ſmall-pox. With reſpect to the facts of other practitioners, I ſhall at a future time make ſome remarks on them, to render their accounts conſiſtent with thoſe of Dr. Jenner, Dr. Woodville, and mine. In the mean time I will not allow that any perſon's evidence is on this point much to be depended upon, unleſs he really know what are characters of the cow-pox puſtule, and what are thoſe of the variolous and ſome other common eruptions.

From the preceding general reſults, without entering into a more particular account, I think we may ſafely conclude, that the cow-pox inoculation is attended with advantages ſufficient to force its way ſpeedily into general practice, and that of courſe it will ſuperſede and ultimately extinguiſh the ſmall-pox: but this concluſion is only drawn proviſionally, *viz.* that no new facts ſhall ariſe adverſe to the experience now poſſeſſed.

With regard to the ſecond object of this paper, Dr. Jen-

ner, very usefully to human society, and very honourably to himself, first published some FACTS, which I thought it my duty, in common with other members of the profession, to investigate, and have laid before the public. Among these *facts* the 4th and 5th were asserted by me in these terms:

IV. *A person having been afflicted with the specific fever and local disease produced by the cow-pox poison, is liable to be again affected, as before, by the same poison; and yet such person is not susceptible of the small-pox.*

V. *A person is susceptible of the cow-pox who has antecedently been affected with the small-pox.*

Neither of these facts being supported by any analogy, a great part of the public seemed inclined to disbelieve them; and not only inclined to disbelieve these facts, but the credit of the others was for obvious reasons thereby weakened. It may be seen in my *Inquiry*, that I thought the assertions stood in need of confirmation, which I was not only unable to procure, but contravening evidence was obtained. Some of my correspondents not only asserted that men were not affected more than once, but that the same cows had not been known to be affected more than once. It was also positively asserted by some, that "a person is not liable to the infection of the cow-pox after going through the small-pox, (p. 49, *Inquiry*:) and I saw persons pitted with the small-pox who had been much exposed to the cow-pox without taking it, (*Ibid.* p. 50.) Notwithstanding my confidence in Dr. Jenner's evidence, I could not help pointing out, in the following words, what I apprehended was a source of error in both cases:—"The evidence for this fact (viz. IV.), to my apprehension, only proves satisfactorily that the *local affection* of the cow-pox may occur in the same person more than once; but whether the *peculiar fever* also occurs more than once in the same person from the cow-pox poison does not appear certain, and must be determined by future observations made with a particular view to this point." Farther: I was so dissatisfied that I wrote to Dr. Jenner to answer

anfwer my query, Whether, in the inftances of the cow-pox occurring more than once in the fame perfon, it was certain that the fpecific fever was prefent more than once? The Doctor very obligingly anfwered my letter, and fays, (fee Dr. Jenner's Letter, p. 99. of my *Inquiry*,) "You may be affured that a perfon may be repeatedly affected *both locally and generally* by the cow-pox; two inftances of which I have adduced, and have many more in my recollection." But he very candidly adds: "Neverthelefs, on this important point I have fome reafon to fufpect, that my difcriminations have not been, till lately, fufficiently nice."

With refpect to Fact V. I faid in my *Inquiry*, p. 49: "It feems fufficiently authenticated that people may have the cow-pox after they have had the fmall-pox; but it will require more nice attention to fatisfy the query, Whether, in fuch cafes, the cow-pox affects the whole conftitution, or is only a local affection?" Subfequently to this obfervation I find Dr. Jenner himfelf, from a theoretical confideration, offers as a "conjecture what experiment muft finally determine that they who have had the fmall-pox are not afterwards fufceptible of the primary action of the cow-pox virus." (Farther Obfervations, &c. by E. Jenner, M.D. &c. p. 32.)

I fhall now relate the *trials* I have inftituted, and the *obfervations* I have made, to obtain *determinations* with refpect to thefe important queftions of facts.

Trials to determine whether or not Perfons are fufceptible of having the COW-POX PUSTULE *and* FEVER, *who have undergone the Small-pox.*

The four firft-named gentlemen being engaged with me in profecuting phyfical inquiries, were defirous to experience, in their own perfons, the effects of the *vaccine poifon*.

1. Mr. Dangerfield was inoculated in one arm by means of a puncture with a lancet ftained with frefh but dried matter, rendered fluid by fteam juft before it was inferted. The other arm was inoculated with thread impregnated with *vac-*

cine

cine matter by paffing it through the fkin. On viewing the arms in three days time, that with the thread appeared inflamed, fhowing a red elevated fmall fpot; the other arm, which had been punctured, barely fhewed a red mark. The punctures had fmarted for about twenty-four hours, but no other effects were produced. Thefe red fpots difappeared in a few days.

In three weeks further the inoculation was again inftituted, but with fluid lymph applied, immediately from the puftule of a patient prefent, to punctures in each arm. More fmarting and more inflammation were produced by this inoculation than by the former. A fmall quantity of pus was produced in the little red fpots from the punctures in about fix or feven days, but no diforder arofe in the whole conftitution.

Mr. Dangerfield was next inoculated in one arm with variolous matter. In the evening of the day of inoculation inflammation appeared, which increafed to a greater degree and extent than from the vaccine inoculations. A fmall phlegmonic tumor in the part inoculated with variolous matter continued for a fortnight, during which time it fuppurated, and the pus from it did not heal in lefs than three weeks further. There was no conftitutional affection; but there was pain in the arm-pit in about five days from the inoculation.

2. Mr. Pollock was inoculated in each arm with a lancet armed with fluid matter immediately on taking it from a patient. A little fmarting was felt for a day or two, and the parts inoculated were red for feveral days; but no puftules arofe, nor conftitutional affection.

3. Mr. Perkins was inoculated by puncturing *one* arm with a lancet ftained with recent *vaccine matter*, and the other was inoculated with *variolous matter*. A red fpot was feen on each of the parts inoculated the day following; and an itching fenfation, efpecially from the vaccine matter, was experienced for a day or two. The parts remained elevated and inflamed a little for a few days further, and then got

well without suppurating, or being attended by any general disorder.

4. Mr. Armitage, whose constitution was fat and muscular, was inoculated in each arm, with a lancet stained with limpid vaccine matter, immediately on taking it from a patient present. A small red spot was observed the day following, and a little burning sensation was complained of; the red spots grew larger and larger for four or five days, and at length produced a small unequal hard tumor, in which a little pus was generated; but the parts soon got well without any attending disorder of the whole constitution.

In a fortnight after this, each arm was inoculated with variolous matter. More inflammation than from the vaccine inoculation arose in a few days, with small tumors, which suppurated: the parts inoculated remained sore for more than a fortnight, but no feverish symptoms ever appeared.

5. G. P. a boy 12 years of age, who had gone through the small-pox ten years before, was inoculated in one arm with recent vaccine matter, which had been dried on a lancet, and was moistened just before it was inserted. The day following not so much as a red spot of the part inoculated was seen, nor had there been any uneasy sensation. He was therefore inoculated a second time, but with fluid lymph immediately from a patient.

The day after the second inoculation an itching sensation of the punctured part was complained of, which continued for two or three days. The part punctured had a small red elevated spot upon it the day after the inoculation, which grew gradually larger for four or five days, and became a little phlegmonic tumor, but without any red surrounding areola. In a few days the little swelling subsided, but a red and rather sore spot remained for a week longer. No disorder of the whole constitution was perceived.

6. Dr. Woodville inoculated me in one arm with vaccine

lymph

lymph from a subject present. The punctured part smarted a little all the remainder of the day of the inoculation, and also the day following. In twenty-four hours a red spot on the inoculated part was seen exactly like that which is often seen in the same time when either the vaccine or variolous infection has taken effect, and which increased for another day; but after this the redness vanished, and no sore was left.

I once accidentally punctured the back of my hand with a lancet which had fluid vaccine matter upon it. The consequence was, a circumscribed, very small, red, hard tumor: this remained for a fortnight, then suppurated, and afterwards burst. The part soon healed, but left a very small superficial cicatrix.

As belonging to this head, I mention, that I have seen several instances of nurses having small, red, conical tumors on their lips and cheeks, and sometimes hands; evidently from the application of cow-pox matter of the children under their care during the vaccine inoculation. These little tumors sometimes remained for several weeks, and a particle of pus was formed in them: they never were attended by any fever symptoms, nor by any surrounding erythematous areola.—I here speak of nurses who had long before passed through the small-pox.

I have no hesitation to refer the following cases to this head of unsusceptibility of taking the cow-pox to having previously gone through the small-pox.

A servant of Thomas King, Esq. about 18 years of age, was brought up during his infancy under circumstances in which he could get no testimony to his having had, or *not* having had, the small-pox. Not having undergone this disease to his own knowledge, it was thought adviseable, in order to resist the small-pox, with which his fellow-servant was seized, to inoculate him for the cow-pox. This I did on Thursday the 23d of March, in one arm with matter on a lancet, and in the other with dried matter on a bit of thread.

4th Day, Sunday 26. The parts inoculated had smarted

for the two first days, and they now were red and a little elevated, as if the infection had taken effect.

6th Day, Tuesday 28. Inflammation had almost entirely gone off: inoculated a second time in both arms with matter from a different patient.

3d Day of second Inoculation, Thursday 30. Punctured parts appeared inflamed.

6th Day, Sunday April 2. Inflammation had disappeared. Inoculated a third time with limpid fluid matter from a patient present, and with which matter I had excited the vaccine disease in several persons.

7th Day of third Inoculation, Friday April 7. The parts inoculated had inflamed and felt painful for two or three days, but were now well.—Inoculated him a fourth time with *small-pox* matter in both arms. A little inflammation arose, but nothing more.

This young man frequently visited his fellow-servant in the small-pox, and shook hands with him, at the Small-pox Hospital, while under my care for the cow-pox inoculation. In this case, either the small-pox had already affected the constitution, or some other disposition existed, rendering it equally unsusceptible of the small-pox and cow-pox.

From Dr. Mitchell of Chatham, whose report is now before me, I learn, that there were several instances of soldiers to whom the cow-pox could not be communicated; and although they had no recollection themselves of having had the small-pox, it was most probable they had passed through it. If I had seen any case of genuine cow-pox pustule and specific fever in a constitution which had previously suffered the small-pox, I should have related it; but I ought to mention that such a case has fallen under the observation of Dr. Woodville, (*Reports*, p. 52 and 143.) I shall never object to the testimony of so experienced a physician without more than usual consideration; but I cannot avoid here observing, that the evidence in his case, of the patient having had the small-pox *when a child*, is merely that of the patient; and

I submit

I submit to Dr. Woodville, whether or not that evidence is admissible to build upon, now that we have the above unequivocal contravening cases of the fact asserted. But I trust the Doctor will be less tenacious of this instance, as he himself tells us that he failed to excite the vaccine disease by inoculating several patients who were recovering from the natural small-pox. (*Reports*, p. 144.)

Whatever impression the above instances may have made on my own mind, I do think they will produce conviction in the mind of every practitioner, *that it is a law of the human animal œconomy to be rendered unsusceptible of the cow-pox fever and specific pustule by undergoing the small-pox*. Hence I find that my expectation of the hands of physic being strengthened by the possession of a sure means of exciting an innocent fever is not realised, (*Inquiry*, p. 81;) but I feel some consolation from the prospect of the new inoculation being more speedily introduced by the removal of one obstacle, viz. the fears of many persons, who have already passed through the small-pox, that they would be liable to the cow-pox, if the diffusion of the infection of it became extensive by the vaccine inoculation. Another advantage suggested in my *Inquiry*, p. 92, is now, I think, greatly confirmed; namely, an *advantage for those who are not certain whether or not they have had the small-pox, but possess so great a dread of this disease as not to be able to submit to inoculation for it*. I congratulate such persons on the discovery of a test to which I apprehend the more timorous minds will submit: for if the *specific pustule* and *fever* do not take place from the inoculation of the cow-pox poison, they may be assured, that either they have already passed through the small-pox, or that their constitutions are not susceptible of it.

It now seems to me, that the following facts are established on the ground of experience:—

I. *A constitution which has undergone the small-pox, is unsusceptible of again undergoing this disease.*

II. *A constitution which has not undergone the small-pox, but which has undergone the cow-pox, is unsusceptible of undergoing the small-pox.*

III. *A constitution which has not undergone the cow-pox, but which has undergone the small-pox, is unsusceptible of undergoing the cow-pox.*

Now, if the variolous poison destroys the susceptibility of the constitution to the future agency of this poison, in the respect of its producing the small-pox; and if the cow-pox poison destroys the susceptibility of the constitution to the future agency of the variolous poison, in the respect of its producing the small-pox; and if the variolous poison destroys the susceptibility of the constitution to the future agency of the vaccine poison, in the respect of its producing the cow-pox; it seems demonstrated, that the same state of unsusceptibility of the constitution, with respect to the future agency of the variolous poison, is produced equally by the agency of the variolous poison, and by the vaccine poison. But if the variolous poison produces unsusceptibility of the constitution to the future agency of the vaccine poison, and the vaccine poison produces unsusceptibility to the future agency of the variolous poison, it seems also demonstrable, that the following 4th proposition is true; viz.

IV. *A constitution which has undergone the vaccine disease, is unsusceptible of again undergoing that disease from the agency of the vaccine poison*: because a state of unsusceptibility, with respect to the agency of the variolous poison, is produced by the vaccine poison (*2d propos.*); and a state of unsusceptibility, with respect to the agency of the vaccine poison, is produced by the variolous poison (*3d propos.*): but the state of the constitution being the same in the two cases, whether it be produced by the variolous or vaccine poison, with respect to unsusceptibility, it seems inevitably, in course, that unsusceptibility of the constitution to the future agency of the vaccine poison is produced by the vaccine disease:

disease: and the demonstration in course could be given of proposition 1, on the ground of the 2d and 3d *proposition*, that unsusceptibility of the constitution to the agency of the variolous poison is produced by the variolous disease, if this were not already proved by abundant experience. At a future time, however, I shall relate the observations and experiments to confirm this *à priori* conclusion; 1st, because these proofs will increase the validity of the 3d *proposition*; and 2dly, because I do not mean to offer this demonstration as infallible, like mathematical.

From the preceding reasoning it may be imagined, that I consider the cow-pox and small-pox as only varieties of the same species of disease; and that therefore the name *variola vaccina* is appropriate, although I endeavoured to show that it was unjust, and tended to mislead, by giving erroneous notions, (*Inquiry, p.* 108). But it must here enter into our contemplation, that the same state of an animal or other substance, in a certain respect, may be produced by very different things; and the phenomena attending their agency may be very different from one another. It is so in the instances under consideration; and further, in order to establish resembling things to be *varieties of the same species*, we ought to be able to trace them to one common origin, or to show that they all agree in what should be reckoned essential properties. Now hitherto it has not appeared that the cow-pox has arisen from the small-pox, or the small-pox from the cow-pox. If it be said, that in some of the eruptive instances of the cow-pox, the pustules could not be distinguished from the small-pox, it should be considered that it has not been yet shown, that in any case the small-pox has changed into the cow-pox;—that the cow is susceptible by inoculation of the human matter of the cow-pox, but not of the small-pox; and that the pustules resembling the small-pox, which occur in the cow-pox, afford matter which, I believe, produces in some cases (if not, perhaps, in so great a proportion as originally) the cow-pox in its usual mild way,

viz. a puſtule in the inoculated part only, and a ſlight fever. Hence I humbly am of opinion, but ſubmit the queſtion to the deciſion of ſcholars, that the uſe of the denomination *variola vaccina* is a tranſgreſſion of the law in philology, and repugnant to ſound logic.

Extended as this paper is, much beyond the limits propoſed, I cannot confine to myſelf the gratification from the reports of the *new inoculation*. I ſhall only mention, however, one or two of them. The ſenſation excited on the Continent, by the vaccine practice, has been much more conſiderable than in our own iſland, as I learned firſt from Dr. Marcet, and ſince by a letter from Dr. Peſchier. At Vienna Dr. Ferro inoculated two of his own children with vaccine matter which I tranſmitted: and next, Dr. De Carro inoculated two of his own children. An accurate journal of theſe laſt caſes was kept by Dr. De Carro, which he has had the complaiſance to communicate to me. The above patients had the diſeaſe in the uſual mild way, and were ſubſequently inoculated for the ſmall-pox, but without effect. Dr. Frank, it is expected, will adopt the vaccine inoculation; as it appears will be generally done at Vienna. I often ſend matter on a thread, which is to be kept for a long time, in a bottle filled with quite dry hydrogen or nitrogen gas. I ſhall ſoon have reports from Portugal, and other parts of the Continent.

In Scotland the new inoculation has not been leſs ſucceſſful. Dr. Anderſon, of Leith, informs me he has inoculated above 80 perſons—that Dr. Duncan and others have begun the practice at Edinburgh; and that it has been introduced in Dundee, Paiſley, and Dalkeith.

If the vaccine inoculation proceed with equal mildneſs as it has done the laſt four months, doubtleſs the variolous inciſion muſt in no remote period be ſuperſeded. And if ſuch an event ſhould take place, poſterity will behold with amazement the prejudices and inattention of their predeceſſors to the application of a fact in practice, by which a formidable

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and loathſome diſeaſe was extinguiſhed—a fact well known, time immemorial, to almoſt every farmer in half a dozen counties of England, but neglected till *Jenner* had the courage to indicate the advantages of it to ſociety. If I were to name a parallel inſtance of inattention or prejudice, it ſhould be the neglect of inoculation for the ſmall-pox, till it was introduced into England from Conſtantinople; although it had been practiſed, time immemorial, in the Barozzo mountains, on the frontiers of Gallicia, in the ſame rude manner as it is at this day *.

XVIII. *Query reſpecting the natural Boundaries between Europe and Aſia.*

To the Editor of the Philoſophical Magazine.

SIR,

THE variety of uſeful geographical communications in your valuable ſcientific miſcellany, encourages me to hope that ſome of your correſpondents may be able to inform me of what many of the geographical publications, to which I have had recourſe, give no ſatisfactory account: it is, What are the boundaries between Europe and Aſia? The laſt edition of the Encyclopædia Britannica, to my great ſurpriſe, gives nothing but a ſtring of contradictions. Under the article *Oby*, that river is ſaid to form the boundary between Europe and Aſia; yet, in the wretched maps given in this expenſive work, the range of mountains known by the name of Oural is marked as the boundary. Neither are the Oural mountains mentioned at all in their proper place; but, under the article *Mountain*, "the Ouralic chain is ſaid to form a

* This intelligence was communicated to me by a Portugueſe nobleman, whoſe opportunities of information and accuracy authoriſe me to mention the fact; but an atteſted account from ſome of the inhabitants is intended for me. See alſo a book written by *Jacobus a Caſtro Sarmento.*

natural boundary between Europe and Asia." And in Vol. VII. p. 39, when enumerating the boundaries of Europe, it is said to be "separated from Asia in part by the Archipelago, as also by the Black Sea, then by the river Don till it comes near the river Volga or Wolga, and then it is parted from Asia by this last, and afterwards by the river Oby."

The greatest instance of inaccuracy, however, is when, enumerating the boundaries of Asia, Vol. II. p. 393, it is said to be "separated from Europe by the Mediterranean Sea, the Archipelago, the Black Sea, the Palus Meotis, the Don, and the Dwina, which fall into the White Sea." Such are the contradictions to be met with in that heterogeneous, though in many instances justly celebrated work. The gazetteers of Watson, Salmon, and Brookes, uniformly contradict themselves, describing the river Oby as being the boundary between these two quarters of the world, and their maps representing the chain of Oural mountains as the boundary. It is not so much to be wondered at in gazetteers, which are, generally speaking, catchpenny publications, servilely copying from each other, even their very faults, except Crutwell's lately published, and an excellent little pocket one, Peacock's: it is, however, to be regretted, that the editor of that most useful and excellent geographical grammar, Guthrie's I mean, has also fallen into this error.

If any of your correspondents will inform me how this matter is, it will be considered as a favour by one who has already received much entertainment and information from the Philosophical Magazine.

August 12, 1799. L. M.

P. S. There is a similar mistake to be found in most geographical descriptions of Ireland; the county of Clare being enumerated amongst the counties of Munster, and the map representing it as part of the province of Connaught, which certainly appears its most natural appropriation.

INTEL-

INTELLIGENCE,

AND

MISCELLANEOUS ARTICLES.

MINERALOGICAL SOCIETY OF JENA.

IN the public fitting of the Mineralogical Society of Jena, held on the 26th of May at the Ducal Palace, Mr. Bodo, from Hungary, read a paper to prove that organifation cannot be denied to any natural body, and that the divifion into organifed and unorganifed is confequently inadmiffible. M. Stark, the fecretary, read a paper fent in by M. Mihalik, of Dopfchau in Hungary, on the following queftion: Whether mineralogy could exift as a fcience without the help of chemiftry? — Dr. Bonzel propofed, that various minerals now arranged under one general name, fhould in future, on account of their peculiar marks of difference, be feparated in the fyftem, and be diftinguifhed by particular names. Thus, for example, that the red zeolite, from Faffa in the Tyrol, fhould be called *Faffaite*, to diftinguifh it from the real Icelandic zeolite; and that the fchorl, from Oifans in Dauphiné, fhould be called *Oifanite*, to diftinguifh it from that of Thum in Saxony.

LITERARY NEWS.

That moft learned, indefatigable, and amiable cultivator of fcience, R. Kirwan, Efq. is now in London, where he has been for the laft three months. With fincere pleafure we can announce that this revered veteran is printing and preparing for the prefs three valuable works :—

1. *A Treatife on the Analyfis of Mineral Waters:* a moft difficult and nice fubject, and which will require all Mr. Kirwan's mental powers and knowledge to treat of fuccefsfully.

fully. Nothing has been done on this subject since the new system of chemistry has been generally adopted.

2. A Memoir on the interesting and fundamental Part of Chemical Science, the precise Quantities of Menstrua and Bases contained in the double Salts with alkaline, earthy, and metallic Bases: whence may be deduced the precise Forces of the Affinities of Bodies.

3. A work on Geology; which will be made not only to accord with the Mosaic Doctrine, but to confirm it greatly.

Of this philosopher permit us to indulge in the wish—

Serò in cœlum redeat.

NATURAL HISTORY.

The following instance of the sagacity of the elephant, which is taken from a late French Journal, may serve as an additional confirmation of what has been so often repeated by various authors both ancient and modern:—

" A sentinel belonging to the menagerie at Paris, anxious to discharge his duty, was extremely careful, every time he mounted guard near the elephants, to desire the spectators not to give them any thing to eat. This conduct was not much calculated to procure him any friendship from the elephants. The female, in particular, beheld him with a very unfavourable eye, and had several times endeavoured to correct his unwelcome interference by besprinkling his head with water from her trunk. One day, when a great number of people were collected to view these animals, the opportunity seemed convenient for receiving, unperceived, a small bit of bread; but the rigorous sentinel was on duty. The female, however, placed herself before him, watched all his gestures, and, the moment he opened his mouth to give his usual admonition to the company, discharged in his face a large stream of water. A general laugh ensued; but the sentinel having calmly wiped his face, stood a little to one side, and continued as vigilant as before. Soon after

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he found himſelf under the neceſſity of repeating his admonition to the ſpectators not to give the elephants any thing; but no ſooner had he done ſo than the female laid hold of his muſket, twirled it round in her trunk, trod it under her feet, and did not reſtore it until ſhe had twiſted it into the form of a ſcrew."

INTRODUCTION OF THE CAMEL AT THE CAPE OF GOOD HOPE.

Notwithſtanding the great number of travellers who have attempted to penetrate into the interior part of Africa by the way of the Cape of Good Hope, the diſtricts left unexplored are immenſe when compared to thoſe which have been viſited. One of the greateſt obſtacles to travelling in theſe wild and parched regions, is the want of proper beaſts of burthen; for it is well known that cattle cannot long endure thirſt, and that numbers of them employed on that ſervice by travellers have died by the way, and thereby rendered their attempts to proceed farther uſeleſs. This fact muſt be well known to thoſe who have read Vaillant's Travels. Profeſſor Heeren of Gottingen propoſes therefore, in order to remove this difficulty, the introduction of the camel at the Cape of Good Hope. "There can be no doubt," ſays he, "that this animal would thrive there, as the climate is exactly the ſame as that of the countries where it is now found. It would no doubt ſucceed as well in the latitude of 35° S. as the lat. of 35° N. in Syria. The exploring of the interior parts of Africa is not the only advantage which might be derived from the introduction of the camel at the Cape: of what utility would ſuch a beaſt of burden be to the planters, many of whom live at a great diſtance from the Cape town, and can at preſent ſend their productions thither in no other manner than in waggons drawn by four oxen! The principal point, however, would be the opening a commercial intercourſe with the interior part of the country. It cannot be doubted that the ſouthern extremity of Africa is

more productive than the northern, and why might not the Cape be the centre of a trade which in future may become very extensive? But without the assistance of the camel it could never be attempted. The present period is the more favourable for putting this proposal in execution, as the Cape is now in the possession of Great Britain; and even if it should be given up at the next peace, the British government would by this service to the colony raise a monument worthy of its dignity: the expence of transporting a few camels from Mogador would be very trifling."—We agree in opinion with Professor Heeren, and think his proposal well worth attention.

ANIMAL ELECTRICITY.

Dr. Chladni, well known by his discoveries in regard to sound, has lately announced the following observation on animal electricity, which we here give in his own words:

"It might be conjectured, when electricity manifests itself in animals, that it would be equally diffused throughout the whole body on account of the conducting power of the interior parts; yet we are taught by experience, that the opposite kinds of electricity take place in the torpedo as well as in cats, though in a less degree; and perhaps the case is the same in other animals. Some years ago I remarked that a cat which had been rendered electric by stroking with the dry hand, especially when lying near the fire on dry days in winter, exhibited opposite kinds of electricity; and that the principal seat of the one was in the head, and of the other in the back, about two inches from the tail. This phenomenon appeared above all when the animal was upon a chair stuffed with hair, and covered with a woollen cloth, by which it was completely insulated. When the head, and in particular the tip of the nose, or of one of the ears, was touched by the finger, there appeared a small electric spark; the case was the same when the extremity of the back was touched; and in this manner sparks could be drawn alternately from the anterior and posterior parts of the body in the same manner

ner as ſparks can be drawn alternately from an inſulated charged jar. I afterwards obſerved the ſame thing in another cat; but, as at that time I paid little attention to this part of philoſophy, and ſuppoſed that the exiſtence of the oppoſite kinds of electricity in animals might have been known, I made no farther experiments, and could not determine which of theſe electricities was negative and which poſitive. I leave it, therefore, to others to examine this phenomenon with more accuracy."

METEOROLOGY.

A very ſingular work was publiſhed laſt year at Liegnitz in Sileſia, entitled *Aphoriſms reſpecting the Influence of War on the Atmoſphere, Weather and Fertility of the Earth.* Among the author's obſervations are the following: If a cubic foot of gun-powder, when it explodes, exerciſes a force equal to twenty-nine millions of pounds, it by theſe means produces a great change in the elaſticity of the air; the whole maſs of the atmoſphere, within a large circumference, is violently torn, and billows of air are produced, which roll themſelves upwards and agitate the vapours contained in them. It cannot therefore be denied that the diſcharging of fire-arms and cannon during battles and ſieges, and even at great reviews, muſt have an influence on the atmoſphere, and on the ſtate of the clouds and weather. He quotes inſtances in the time of the ſeven years war, of clouds and vapours being diſperſed by the exploſions of the cannon; and aſſerts that, during his travels through the Tyrol, he ſaw on ſeveral occaſions, to uſe his own expreſſion, the clouds "ſhot dead." He obſerved in the neighbourhood of Liegnitz, while the regiment of Wartenſleben were going through their exerciſe, that the clouds were broken by the exploſions, and that the murmuring of the wind, and the agitation of the leaves of the trees, and the ſmall feathers ſuſpended from any body, were ſometimes ſtronger, ſometimes weaker, according as the troops fired by battalions or companies. The barometer

rofe and fell at each explofion; and water in a veffel, at the diftance of five hundred paces, was violently agitated. There have been inftances of the noife of heavy cannonades, in the laft and prefent war, being heard at the diftance of more than forty miles. Nay, the thunder of cannon penetrates even into the interior parts of the earth, and to the bottom of the fea, fo that whales and herrings have been frightened away to the diftance of two hundred miles. The author, from thefe principles, endeavours to account for certain fingularities which prevailed in the weather in fome parts of Germany in the year 1797; and to fhew that the quantity of gun-powder fired in the time of war may have a fenfible effect on the fertility of gardens and fields. In the feven years war above a million of pounds of powder were fired off in Europe; and it may with certainty be affirmed that no lefs a quantity has been confumed in the prefent war againft the French.

NEW BASIS FOR BLACK PAINT.

A moft excellent bafis for black paint has been difcovered in the Lead-mines of Nant Gwider, in the Vale of Conway, by Mr. Goodwin of Llanrooft, proprietor of feveral mines, of which a defcription and analyfis will be given in fome future number of the Philofophical Magazine, together with that of feveral other fubftances he has difcovered in North Wales, and which it is prefumed will be of confiderable utility.

SUGAR FROM THE BEET-ROOT.

Profeffor Göttling, of Jena, has announced a fmall work, which he intends to publifh foon, on the preparation of fugar from the beet-root. The Profeffor in his profpectus obferves, that the various kinds of beet with which he made experiments, muft be treated in a quite different manner from the fugar-cane, or the method employed by Margraaf, in order to obtain from them good fugar. In regard to the quantity of fugar which they produce, he found very little variation.

tion. Some have ſaid that 100 pounds of roots are ſufficient for eight pounds of ſugar; but Profeſſor Göttling could obtain from 100 pounds of roots no more than two pounds and a half. As the Profeſſor has promiſed to give a full account of the proceſs in his pamphlet, it will no doubt be intereſting to thoſe who wiſh to make experiments on this ſubject.

SIZE MADE OF POTATOES.

One of the beneficial uſes of potatoes, not perhaps generally known, is, that the ſtarch of them, quite freſh, and waſhed only once, may be employed to make ſize, which, mixed with chalk, and diluted in a little water, forms a very beautiful and good white for ceilings. This ſize has no ſmell; while animal ſize, which putreſies ſo readily, always exhales a very diſagreeable odour. That of potatoes, as it is very little ſubject to putrefaction, appears from experience to be more durable in tenacity and whiteneſs; and for white-waſhing ſhould be preferred to animal ſize, the decompoſition of which is always accompanied with unhealthful exhalations.

DEATHS.

On the 29th of April, at Leyden, David Van Royen, Profeſſor of Botany in that Univerſity, in the 70th year of his age.

On the 7th of this month, at his houſe in Newman-ſtreet, John Bacon, Eſq. R. A. the well-known ſculptor. He was a native of Southwark, and, when a child, diſtinguiſhed himſelf by moulding figures in clay, and very early in life obtained prizes from the Academy.

On Thurſday the 22d inſtant, in the 49th year of his age, Mr. Benjamin Thomas Pouncy, engraver; an artiſt of the firſt eminence in his profeſſion. He was the brother-in-law and moſt diſtinguiſhed of the diſciples of Woollett, with whoſe vigour and richneſs of ſtyle he has with peculiar felicity united the freedom and ſimplicity of Vivares; "and, with

with a maſter's hand and poet's fire," has ſecured to himſelf the praiſe of originality, by blending both with his own view of Nature. To enumerate his engravings, and comment on them in the detail, would be more than the preſent diſpoſal of the writer's time will permit; yet the mention of a few of their leading traits is at leaſt due to the merits and the memory of ſo excellent an artiſt. Freedom, boldneſs, and an happy imitation of the wild forms of inartificial Nature are among their diſtinguiſhing features. The drawing of his trees in particular; his diſcrimination of their ſeveral characters; his thorough knowledge of their various modes of growth, combined with a mode of expreſſion ariſing ſpontaneouſly out of his ſubject, have perhaps never been excelled. Among the rude and artleſs landſcapes of the South-ſea iſlands, or the wild and luxuriant forms of lake and foreſt ſcenery, his etching-tool and his fancy would revel delighted, and communicate to every cultivated eye a correſponding pleaſure. With ſuch claims to ſuperior art, men of diſcernment will lament that it was the lot of Pouncy to be obliged to trammel his talents, and employ a conſiderable portion of his time in engraving *fac-ſimiles* from the pages of Doomſday-book; in tracing the Spaniſh lines before Gibraltar; and on other ſubjects that required merely care, and the exerciſe of a certain regular mathematical ability he did not naturally poſſeſs. On the whole, it may be ſaid of his works, which are chiefly after Farington, Hearne, Smith, and Wilſon, that they will continue to be admired wherever legitimate art and true taſte are not obſcured by the falſe glitter ſo much the faſhion of the day; and that, in private life, the hoſpitality of his manners, the compaſs of his knowledge, the liberality of his ſentiments, and the goodneſs of his heart, will long be remembered with regret by thoſe who had the happineſs of being intimately known to him.

L.

THE

PHILOSOPHICAL MAGAZINE.

SEPTEMBER 1799.

I. *On the gradual Changes in Temperature and Soil which take place in different Climates, with an Enquiry into the Cause of those Changes. By the Abbé* MANN *.

VARIOUS authors, both ancient and modern, have written on the subject of this Dissertation, but merely in a cursory manner; one only, Dr. Hugh Williamson, an American physician, has made it an object of particular attention; but what he has said relates only to North America, and is comprehended in a very short paper published in the Philosophical Transactions of Philadelphia for 1777. It has long appeared to me interesting enough to require farther and more accurate examination; but before I enter into any research respecting the causes of those changes of temperature and soil, observed in different countries during a long series of ages, it seems to be necessary first to prove, by authentic testimony, that these changes have actually taken place. This Dissertation divides itself naturally into two parts. In the first I shall collect all the information of an-

* From the *Transactions of the Electoral Academy of Sciences at Manheim*, Vol. VI.

cient authors I have been able to find on the ſtate of the temperature and ſoil in their time in Gaul, Germany, Pannonia, Thrace, Mœſia, Dacia, and the European part of Scythia. As moſt of theſe writers, however, when they ſpeak of the climate of thoſe countries, expreſs themſelves more or leſs in an almoſt unintelligible manner, and nearly in the ſame words, it would be ſuperfluous to quote, at full length, all the paſſages I have collected on the ſubject. I ſhall therefore content myſelf with giving, in regular order, the ſubſtance of all the circumſtances they have communicated to us in regard to the climate of the above countries; and in the ſecond part I ſhall briefly enquire into the phyſical cauſes which, in the courſe of ſeveral centuries, may have gradually contributed to produce theſe changes.

I. *Proofs of the Change of Temperature and Soil in the Climates of Europe.*

We are told by Herodotus, more than once, that in the European part of Scythia, on the Palus Meotis, the winter continued eight months every year with almoſt inſupportable ſeverity; and that the countries farther towards the north were on that account uninhabitable: he adds, that the other four months, called the ſummer, were alſo exceedingly cold. Now this country lies between the 44th and 50th degree of north latitude, and we know at preſent that nothing of the like kind has taken place there for a long time. Cæſar, Virgil, Diodorus Siculus, Ovid, Strabo, Pomponius Mela, Seneca, Petronius, Pliny the naturaliſt, Statius, Herodian, and Juſtin, all ſpeak in the ſame manner of the inſupportable cold of the winter in different parts lying in the ſame latitude of from 44 to 50 degrees between Gaul and the Euxine Sea. They quote ſo many and ſo evident effects of this winter cold, that it is not poſſible to aſcribe their deſcriptions to the manner of life they were accuſtomed to in the warmer diſtricts of Italy, Greece, or Aſia.

The deſcriptions which they unanimouſly give, would at

preſent

present suit those countries which lie between 56 degrees of latitude and the polar circle; and in some respects they seem to exceed the cold of the winter in Sweden and Norway. In order to see realised at present the descriptions which the ancients have given of the climate of the middle part of Europe in their time, it would be necessary to visit Lapland, Siberia, and those regions of America lying to the north of Hudson's Bay, where the state of the climate is the same as that 2000 years ago on the banks of the Rhine and the Danube, the Palus Meotis, the Dnieper, and the Don.

The first effect, uniformly mentioned by the ancients, of the extraordinary cold of the winter in that whole part of Europe between the 44th and 50th degree of latitude is, that all the seas, lakes and rivers contained in those districts were continually frozen in winter, so that armies of barbarians, Scythians and Sarmatians, in order that they might plunder the more southern countries, passed with their horses, waggons and baggage over the ice, which they bestrewed with straw to prevent their sliding. This is expressly asserted by Herodotus, Virgil, Ovid, and Strabo, of the European part of Scythia, Dacia, and Thrace, all countries which lay in a northern and western direction from the Palus Meotis and the Euxine Sea. The same thing is asserted by Diodorus Siculus, Seneca, Pliny the younger, Florus, Herodian, Ammianus Marcellinus, Fernandes the Goth, and Xiphilinus the abridger of Dio Cassius, in regard to the rivers and lakes of Pannonia, Germany, and Gaul. They mark the times when these armies passed the ice, and the wars which they then carried on; so that no doubt can be entertained in regard to testimony so unanimous and authentic. Herodotus says, that the Scythians in this manner over-ran, during winter, all the neighbouring countries as far as India; and we are told by Strabo, that Neoptolemus, the general of Mithridates, beat the barbarians in winter with an army of cavalry, at a place which in summer had been the scene of a naval battle. In the Treatise on Rivers,

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afcribed to Plutarch, it is faid, the Thermodon, a Scythian river, froze even in fummer; a circumftance which never happens at prefent in regard to the rivers of Siberia, Lapland, and Greenland. Ovid tells us, that he himfelf paffed over the Pontus Euxinus on the ice. People, adds he, will fcarcely believe me:

> ———— Sed cum fint praemia falfi
> Nulla, ratam teftis debet habere fidem.

Plutarch fays, that the preffure of this enormous mafs of ice againft the fides of fhips frozen into it, crufhed them to pieces; and he mentions the inftance of a Roman fhip which had experienced that fate in the Danube.* Strabo and Virgil fpeak of brafs veffels burfting by the expanfive force of the ice; and we are affured by Virgil and Ovid, that the people in Thrace and on the Danube cut the wine with axes, and diftributed it in folid portions. They add, likewife, that men's hair and beards were often covered with ice.

> Stiriaque impexis indurent horrida barbis. VIRGIL.
>
> Sæpe fonant moti glacie pendente capilli,
> Et nitet induĉto candida barba gelu. OVID.

If we compare this defcription with the prefent ftate of France, Germany, Hungary, Romania, Tranfylvania, Wallachia, Moldavia, Bulgaria, Leffer Tartary, Podolia, and the Ukraine, it will be found that the prefent temperature of thefe countries has no refemblance to what it was two thoufand years ago: the effects produced there every winter fcarcely take place now once in a century, and when they occur they are confidered as extraordinary phenomena.

From ice I fhall proceed to fnow. Herodotus, Pomponius Mela, and Pliny the elder, fpeak of the European part of Scythia as if its atmofphere was continually filled with fnow and fogs, which prevented the view of the neareft objects, and obfcured the light of the day. We are told by Herodotus, that this immenfe load of fnow, when it fell, made the air appear as if filled with feathers; and that, for this

this reaſon, the country was called *Pterophoros.* Diodorus Siculus ſpeaks of Celto-Scythia as covered with ſnow in the winter time; and the ſame thing is aſſerted by Florus and Petronius. Virgil, ſpeaking of Thrace and the countries on both ſides of the Danube, ſays, that a continual winter prevailed in them; and that the ſnow lay upon the ground ſometimes to the depth of ſeven ells.

> Sic jacet aggeribus niveis informis, et alto
> Terra gelu latè, ſeptemque aſſurgit in ulnas,
> Semper hyems, ſemper ſpirantes frigora cauri.

The picture which Ovid gives of the ſnow at Tomi (in the lat. of $44\frac{1}{2}$) is no leſs horrid, as he tells us that it continued two years without being melted by the ſun or rain:

> Nix jacet et jactam nec ſol pluviæve reſolvunt;
> Et ſolet in multis bima manere locis.

In regard to other meteorological phenomena in the European part of Scythia and Celto-Scythia in the time of Herodotus and the following century, this hiſtorian ſays, that it ſeldom rained in the winter, becauſe at that period it ſeldom ceaſed to ſnow; and that, on the other hand, when the weather in ſummer was dry and fair in Greece and Leſſer Aſia, it never ceaſed to rain in the country of the Celto-Scythians: that during this ſeaſon the heavens were always overcaſt with clouds, and that thunder, even in ſummer, was very uncommon; that when it happened in winter, it was conſidered as a wonder, and that, in thoſe ſeaſons when it took place, earthquakes were obſerved alſo. This laſt circumſtance is indeed worthy of attention, as it ſerves to confirm my conjectures reſpecting the theory of the earth.

Diodorus Siculus, Tacitus, and Ovid, when they ſpeak of Gaul, Germany, and Thrace, take notice of the prodigious force of the wind which prevailed in theſe countries in their time and during the preceding centuries. Theſe winds raiſed even ſtones and men from the earth; carried away the roofs of houſes; tore up trees by the roots, and overturned turrets

and houfes. Such effects of the wind are indeed obferved at prefent, particularly in the countries on the Northern Sea and the Bay of Bifcay, but feldom in thofe parts of the Continent fpoken of by the ancients.

Varro, Diodorus Siculus, Ovid, Pomponius Mela, Seneca, Petronius, Pliny the elder, Tacitus, Appian, Dio Caffius, and Herodian, all agree in faying that the feverity of the climate and weather which in their time prevailed in Gaul, Germany, Pannonia, Thrace, Mœfia, and Dacia, would hardly admit either vines, olives, or any kind of fruit-trees; and that, in cultivating them, it was neceffary to cover them with dung or with earth to preferve them throughout the winter. Tacitus, however, adds, that thefe countries produced, in abundance, various kinds of grain, where the people gave themfelves the trouble to improve and manure their fields by means of marl or chalk, which deftroyed the cold and the moifture. This circumftance is exprefsly remarked by Varro: *Agros ftercorarent candida foffitia creta.* He afterwards adds, that in thefe countries there was neither rock falt nor fea falt: the preparation of the latter required a ftronger heat than exifted in thofe climates *. The inhabitants fupplied the want of falt by faline afhes from certain kinds of wood burnt for that purpofe, and which were drenched with falt water. Pliny and Tacitus give the fame account.

It is obferved by Herodotus, Strabo, and Tacitus, that the oxen in the European part of Scythia and the country of the Celto-Scythians had no horns, or horns exceedingly fmall; which they afcribed to the feverity of the cold and the climate. Herodotus confirms this idea in a negative

* This, indeed, proves nothing in regard to the climate; but it fhews the want of knowledge and induftry. The paffage in Varro *De Re Ruftica*, i. 7. is as follows: *Ubi falem nec foffitium nec maritimum haberent; fed ex quibufdam lignis carbonibus falfis pro eo uterentur.* It is probable that they boiled their falt, as was done in former times in fome parts of Europe; that is, poured the faline liquor over glowing pieces of wood, and collected the falt which adhered to the charcoal. *G.*

manner

manner by the teftimony of Homer, who fays in the Odyffey, that in Lybia the lambs had horns from their birth, owing to the great heat. Strabo, as a proof of the great cold which prevailed in the country now called the Ukraine, obferves that it produced no affes; animals, fays he, which cannot endure the cold: and he adds, that the horfes there were extremely fmall. But nothing, indeed, is more aftonifhing than the teftimony of Paufanias, who fays exprefsly, that in Thrace there were in his time bears and wild fwine of a white colour. Such animals at prefent are found only in the remoteft parts of the north, on the other fide of the polar circle. We are told by Virgil, Ovid, and Pomponius Mela, that the inhabitants of the European part of Scythia and Thrace lived, during the whole winter, under the earth (as the Laplanders do at prefent); that they burnt large logs of wood to keep themfelves warm; that they never went abroad without being wrapped up in fkins; and that they left no part of the body uncovered but the mouth and eyes. Pomponius Mela fays, *Specus aut fuffoffa habitant, totum braccati corpus, et nifi qua vident etiam ora veftiti.*

I think it of importance to point out here the boundaries of thofe countries towards the north, which the ancients confidered as defolate and uninhabitable on account of the great intenfity of the cold. Herodotus fays, that beyond the Melanchlini, a Sarmatian people, fo called from their black hair, there were only lakes, moraffes, and uninhabitable diftricts as far as was then known; and we learn from Ovid that on the other fide of the Cimmerian Bofphorus, the Tanais, and the Scythian moraffes, a cold prevailed which rendered the country uninhabitable.

> Bofphorus et Tanais fuperant Scythiæque paludes;
> Ulterius nihil eft, nifi non habitabile frigus

This is exprefsly confirmed by geographers and hiftorians. Strabo repeats, feveral times, that all the lands towards the north of the tribes who lived on the banks of the Tanais

 and

and the Boryſthenes were uninhabitable on account of the ſeverity of the cold which prevailed in them. But all that has been traced out of the banks, and even the origin of this river, does not lie beyond the 55th degree of latitude; conſequently is on the ſame parallel with the northern part of England and Germany, the middle of Lithuania, and the middle of Ruſſia. Between theſe two rivers Strabo places alſo the Rhoxolani, who in general are conſidered as the anceſtors of the Ruſſians; and he adds, that all the diſtricts farther north were uninhabitable on account of the cold. In another place he ſays, that all the northern part of Britain was very thinly peopled on account of the cold, and that he believed all the countries lying beyond it to be uninhabited. Now no part of Great Britain extends beyond the 60th degree of north latitude; conſequently that parallel includes all Norway, almoſt the whole of Sweden, and the half of Ruſſia. Theſe countries, therefore, in the time of Strabo, that is, about the period of Auguſtus, were conſidered as uninhabited. The ancients, in general, ſpeak of all the lands which lay beyond the 55th degree of north latitude as filled with lakes, moraſſes, ice, ſnow, and fogs, almoſt like thoſe countries to the north of Hudſon's Bay.

Theſe, in my opinion, are ſufficient and unqueſtionable proofs of the exceſſive ſeverity which prevailed 2000 years ago in the climate of thoſe countries of Europe lying between the latitude of 44° and 50° north latitude, and fully eſtabliſh the difference between the ſtate of their temperature in thoſe periods and what it is at preſent. The more northern lands, which the ancients, on account of their unſupportable cold, conſidered as uninhabitable; Iceland, Norway, Lapland, and the northern part of Ruſſia and Siberia, are habitable, and inhabited at preſent, as is well known, though exceedingly cold. The ancients alſo ſpeak of effects produced by the cold of winter in Italy, Greece, Leſſer Aſia, &c. which at preſent are certainly unknown. The ſoil of the latter countries, as well as that of the ancient Aſſyria, Chaldea,

Paleſtine,

Paleftine, the Roman part of Africa, and Spain, is at prefent remarkably ftony, and burnt up with heat. We, however, know, that Spain in particular, about 1800 years ago, was exceedingly rich and fruitful, and abounded with all forts of provifions, which are no longer to be found in it *. It appears to me unneceffary to produce more proofs, as the change of the foil and fertility in all the countries bordering on the Mediterranean Sea, and which formed the richeft and moft beautiful part of the Roman empire, is admitted as a certain fact by all thofe who have fpoken of their former and prefent ftate.

It is therefore beyond a doubt, that the foil and temperature of all the lands from Spain to India, and from the ridge of Mount Atlas to Lapland and the remote parts of the north, have in the courfe of ages, fince the period of the oldeft hiftorical monuments ftill extant to the prefent time, been gradually fubjected to a complete change, from the utmoft degree of moifture and cold, to a great degree of drynefs and warmth. An effect fo continued and uniform muft have fome caufe, which is equally fo itfelf.

Dr. Williamfon afferts, that the climate of America is becoming continually milder; and he confirms it by a number of facts. This effect is directly contrary to the hypothefis of a celebrated naturalift refpecting the theory of the earth and the planets, who afferts, that they have been continually lofing warmth fince they were firft in a ftate of fufion, and are becoming always colder; fo that they will at length be incapable of keeping alive any animal or vegetable production †. All hiftorical and phyfical monuments, however, prove the contrary.

* The diftricts in the neighbourhood of Toledo are deftitute of trees, on which account the heat in fummer is unfupportable, and wood in winter exceedingly dear. When Martial wrote the following lines, the country muft certainly have been in a very different ftate:

> Æftas ferenus aureo franges Tago
> Obfcurus umbris arborum.

† This was the opinion of Buffon. EDIT.

It is not merely in modern times, and fince the improvement of natural philofophy, that this change of temperature and foil has been remarked. A great number of places, well known and defcribed by the ancients, in Paleftine, Syria, Leffer Afia, Greece, Italy, Spain, and Barbary, exhibit proofs of the changes which have taken place in the foil and temperature in the courfe of time. Every one knows their prefent dry and barren ftate, which feems to be paft remedy. It is fo contrary to that in which they were formerly, according to all the defcriptions of them left us by Greek and Roman authors, that it is impoffible for us to afcribe this difference merely to the inclination of the ancients for exaggeration *: the clear and precife facts, which various celebrated authors have mentioned refpecting them, will not allow of fo abfurd a fuppofition. Ovid fays that, in his time, Lower Mœfia, to which he was banifhed, produced neither vines nor fruit-trees,

> Nam procul à Getico littore vitis,
> Nam procul à Geticis finibus arbor abeft.

Strabo, who was a few years later than Ovid, fpeaking of vine plants in the Thracian Bofphorus, fays, that in winter it was neceffary to bury them under the earth in order to preferve them. Not long after, it was obferved by Pomponius Mela and Pliny the elder, in fpeaking of Thrace, that there were fcarcely any fruit-trees in that country, and that in winter it was neceffary to cover them with dung. Mela adds, that the vines often grew there, but that the grapes never ripened †. Columella is the firft author who fpeaks of vines in Gaul; and he fays that the Sabines and the Romans in the preceding century had procured, amidft the devaftation of war, more abundant crops than had been procured in his time during a ftate of perfect peace. But no-

* Voltaire pays this compliment to the authors of the Bible in regard to Paleftine.

† Vitem frequentius tolerat, fed nec ejus quidem fructus maturat ac mitigat.

thing

thing in this reſpect is more ſtriking than what is obſerved by Columella in regard to the changes of climate. "I find," ſays he, "that it is the opinion of many reſpectable authors that the quality and ſtate of the atmoſphere become changed in the courſe of a long ſeries of ages: for Saſerna, in that work which he has left on agriculture, infers that the ſtate of the atmoſphere is changed, becauſe certain diſtricts, which formerly were incapable of producing vines or olives on account of the continual ſeverity of the winter, now yield abundant vintages and plenty of oil by the climate having become milder and warmer*." But it is now time that I ſhould proceed to an inquiry into the cauſes that produce theſe changes, the effects of which I flatter myſelf I ſhall be able to prove.

[To be concluded in next Number.]

II. *Obſervations on the Vibration Nodes of Muſical Strings.* *By* J. G. VOIGT *of Halle*†.

EXPER. I. Divide AB, the ſtring of a monochord, into any number of equal parts, for example four, by the points CDE, and place a moveable bridge at E; put on the points C, D of the ſtring, and any others at pleaſure, light bodies, ſuch as ſmall bits of paper, and draw a violin bow, rubbed with roſin, over the part EA; you will hear the tone correſponding to the part EA, which is to the tone of the whole ſtring AB as 4 : 1; and all the bits of paper, except thoſe lying on the points

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  C  D  E
A.—.—.—.—.B
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* Multos enim memorabiles auctores comperi perſuaſum habere, longo ævi ſitu qualitatem cœli ſtatumque mutari ————. Nam (Saſerna) eo libro quem de agricultura ſcriptum reliquit, mutatum cœli ſtatum ſic colligit, quod, quæ regiones antea propter hiemis aſſiduam violentiam nullam ſtirpem vitis aut oleæ depoſitam cuſtodire potuerint, nunc mitigato jam et intepeſcente priſtino frigore largiſſimis olivitatibus, liberique vindemiis exuberent. *De Re Ruſtica*, Lib. i. cap. 1.

† From Gren's *Journal der Phyſik*, Vol. II. part 3.

C and D, will, by the vibration of the ſtring, be thrown from it. The points C and D are called vibration nodes. In this, and all the other experiments of this kind, the point where the bridge ſtands is alſo a vibration node.

II. Divide the ſtring AB into a number of equal parts at pleaſure, for example five; cut off, by removing the bridge to E, two of theſe parts (this number 2 and the other 5 muſt have 1 for a common diviſor); place upon the points of diviſion C, D, F, and any others of the ſtring taken at pleaſure, light bodies, ſuch as bits of paper; draw the violin bow over the part EA, and all the bits of paper except thoſe on C and D will then be thrown off, and you will hear a tone which is to the tone of the whole ſtring as 5 : 2, and which correſponds to the tone of the part EA.

   C D E F
A.—.—.—.—.—.B

III. Divide a ſtring AB into any number of equal parts, for example ſix, by the points C, D, E, F, G; cut off as before, by removing the bridge to F, two parts (this number 2, and 6 the number of the parts of the whole ſtring, muſt have a greater common diviſor than 1); place upon the other four points of diviſion C, D, E, G, and on any others of the ſtring taken at pleaſure, light bodies, ſuch as bits of paper; and all theſe, except that at D, will be thrown down by rubbing the bow againſt FB, the part cut off by the bridge; you will alſo hear a tone correſponding to the part FB, which is to the tone of the whole ſtring as 6 : 2 or 3 : 1.

   C D E F G
A—.—.—.—.—.—.B

IV. If you place upon the ſtring, without cutting off any part of it by the bridge, different bits of paper in points taken at pleaſure, and rub with the bow ſo as to make the whole ſtring ſound, all the bits of paper will be thrown from it. This experiment will give the ſame reſult when you cut off in the middle the part of the ſtring which actually ſounds; for example, you may vary the ſecond experiment thus:—

V. Divide the ſtring AB by the points C, D, E, F, into five equal parts; cut off, by means of two moveable bridges, the part DE; place upon C and F, and other points of the ſtring AB, ſmall bits of paper: rub the bow againſt ED; all the bits of paper will be thrown off except thoſe in C and F, and you will hear the tone correſponding to DE, which is to the tone of the whole ſtring as 5 : 1.

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  C D E F
A.—.—.—.—.—.B
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From theſe few experiments, the following laws reſpecting vibration nodes may be deduced:—

1. The part of the ſtring apparently at reſt is not perfectly ſo, but only its vibration nodes.

2. The original vibrating part of the ſtring, which is brought into immediate vibration by rubbing with the violin bow, has no vibration nodes; and therefore no ſtring on the violin, violoncello, harp, or harpſichord, can have any. All the vibration nodes on theſe inſtruments lie behind the bridge.

3. For vibration nodes to be poſſible, a part of the ſtring muſt be apparently at reſt; conſequently, the number which expreſſes the height of the tone emitted, as compared with the tone of the whole ſtring = 1, muſt be greater than one, and muſt therefore be expreſſed by an improper fraction.

4. In order to determine the number of the vibration nodes of a ſtring for the tone $\frac{a}{b}$, where, as before ſhewn, a muſt be greater than b, we need only reduce the fraction $\frac{a}{b}$, which expreſſes the proportional height of the tone, to its loweſt terms $\frac{p}{q}$, and ſubtract the ſmaller number q from the greater p: the difference $p-q$ will be the number of the vibration nodes. This law follows very naturally from the preceding experiments.

When the height of the tone to be produced is to the tone of

of the whole ſtring as $\frac{a}{b}$, $\frac{b}{a}$ parts of the ſtring muſt be rubbed with the bow in order to produce that tone, that is, the ſtring is divided into a parts, and b parts muſt be cut off and rubbed with the bow; therefore $a-b$ are parts of the ſtring, or $\frac{a-b}{a}$ of the whole ſtring apparently at reſt, the extreme points of which are capable of producing vibration nodes; and when $\frac{b}{a}$ is brought to its loweſt expreſſion, it gives $a-b$ vibration nodes. If $\frac{b}{a}$ be not in its loweſt terms, let its loweſt terms be $\frac{q}{p}$; ſo that $\frac{b}{a} = \frac{q}{p}$, and when e is the greateſt common diviſor of a and b, a will be $= ep$, and $b = eq$; therefore $a-b = e(p-q)$. Now, if it ſhould be required to apply this law to $\frac{b}{a}$, the number of the vibration nodes $a-b$ muſt be $= e(p-q)$; but if applied to $\frac{q}{p}$, as above demonſtrated, the number of the vibration nodes will be $p-q$; therefore $e(p-q) = p-q$, which can no otherwiſe be true than when e is $= 1$, that is, $\frac{b}{a}$ or $\frac{a}{b}$ muſt be expreſſed in its loweſt terms.

5. As the members of two fractions not of the ſame value may have the ſame difference as $\frac{3}{7}$ and $\frac{1}{5}$, the ſame number of vibration nodes may exiſt where the tones are different, and therefore each tone has not its own peculiar number of vibration nodes.

6. Vibration nodes are only poſſible where the tones have a certain ratio to the fundamental tone.

It muſt not, however, be expected, that the experiment can be made, for example, with a ſtring 26 inches in length, in ſuch a manner that you can divide it into 40 or 50 parts, and rub one of them with the bow; for in this caſe the vibration nodes, or points at reſt, are at ſo little diſtance from each

each other that a piece of paper will cover more than one vibration node, and will be thrown off by rubbing with the bow, though they ought to remain; or the vibration will be too weak, and not be ſufficient to throw off the bits of paper which ought to fall.

III. *Agenda, or a Collection of Obſervations and Reſearches the Reſults of which may ſerve as the Foundation for a Theory of the Earth. By* M. De Saussure.

[Continued from page 265.]

CHAP. XIX.

Reſearches to be made in regard to Earthquakes.

1. THE hiſtorical part: the greatneſs, extent, and chronology of their ravages in different countries.

2. Does it appear that ſome countries are more expoſed to them than others; are there ſome abſolutely exempted; and how far is this connected with the local ſituation of the country?

3. To obſerve the extent, duration, and direction of the vibrations experienced by the earth when it ſhakes.

4. Are there any meteorological phenomena that announce or accompany earthquakes; ſuch as extraordinary heat, calms, ſtorms, movements of the barometer, electricity, vapours diſperſed throughout the atmoſphere, paleneſs or peculiar colour of the ſun and ſtars?

5. Other phenomena; ſuch as ſubterranean noiſe, extraordinary movement of the ſea, the water of ſprings increaſed or dried up, any particular ſmell, ſymptoms of terror among domeſtic animals.

6. Are there any indications that ſome earthquakes may have been the effects of electricity, and that ſuch convulſions might be prevented by conductors?

7. Are there not ſome alſo which immediately depend on ſubterranean

ſubterranean fires; and which are preceded by or accompanied with volcanic eruptions?

8. Are there any which exhibit indications of the effects of water converted into ſteam?

9. To aſcertain the ſimultaneous or at leaſt aſtoniſhing rapidity of the effects of earthquakes at very great diſtances.

10. Are there any inſtances that, during the moment of an earthquake, ſome pretty conſiderable tract of land, or a mountain, has been raiſed to a great height above its former level, and has afterwards remained in a ſtate of elevation?

11. Are there dry fogs, ſuch as that of 1783, which may be conſidered as vapours, that have iſſued from the earth by the action of ſhocks or concuſſions.

CHAP. XX.

Obſervations to be made on Mines of Metal, Coal, and Salt.

1. The hiſtorical part: the epoch of the diſcovery of a mine; of its being firſt worked; the expence and net produce at different periods. If there ever was, or ſtill is, a grant of it, and on what conditions.

1. A. In regard to the phyſical part, care muſt be taken to examine whether the ore be in veins or ſtrata; that is to ſay, whether it interſects the ſtrata of the mountain, or be parallel to them.

2. In mines which conſiſt of veins, the dimenſions, thickneſs, and length of the veins are to be examined; their inclination in regard to the horizon, and their direction in regard to the cardinal points. The miners call this direction the *hours*.

3. The metal it contains; the mineraliſing ſubſtance, and the kind of mineral which thence reſults.

4. The matrix, or non-metallic foſſil, found mixed with the ore.

5. The nature of the ſoil at the bottom, or that part of the mountain on which the vein reſts; nature of the covering, or part of the mountain immediately above it.

6. Nature

6. Nature of the covering of the veins, or thofe parts of the vein next to the fubftance of the mountain.

7. Nature of the *drufes*, or cryftallifed *geodes* contained in the vein.

7. A. The form, dimenfions, and nature of the mountain which contains the vein.

8. Situation of the vein in regard to the ftrata of the mountain; under what angle it interfects them.

9. Its fituation in regard to the exterior part of the mountain; whether it be parallel to the external inclination of the mountain, or whether that inclination be in a contrary direction.

10. The progrefs of the vein: whether it be fubject to change its direction or fituation, and according to what laws; if there are any indications that precede thefe changes; any corners, vacuities, or fiffures, which interrupt the courfe of the vein; and how it is found after having been loft: fituation and diftance of the place where it is richeft.

11. Lateral veins or ramifications of the principal vein; veins by which it is accompanied, or which run parallel to it.

12. To verify Werner's theory in regard to veins, the fundamental principles of which are as follows:—

A. That the fpaces occupied by veins have been originally empty crevices or fiffures.

B. That thefe fiffures have been afterwards filled from the bottom upwards, at a time when the fea ftill covered the mountains; and by the precipitation or cryftallifation of the fubftances which were before diffolved in the waters of the fea.

C. That of two veins croffing each other, the moft modern is that which interfects the other.

D. That of two veins, one of which ftops and diverts the courfe of the other, the moft modern is the latter.

E. That, in the fame vein, the parts neareft to the fides of the furrounding fubftance, the *falbande* for inftance, are the moft ancient; thofe in the middle the moft modern; and the intermediate ones of a mean antiquity.

F. Alſo that, in the ſame vein, the loweſt parts are the moſt ancient.

G. That in ſome veins there are found rolled pebbles; in others the remains of organiſed bodies, ſhells, and wood; and in others, of coal, ſtones, and ſea-ſalt.

H. That one may aſſign the relative age of the formation of different minerals; for example, that tin mines may be ſaid to be of the moſt ancient formation; then thoſe of uranite, biſmuth, &c.

The greater part of the following queſtions will furniſh confirmations of this theory, or objections againſt it, according to the ſolution given of them:

13. Is it true that there are mountains, or portions of mountains, ſo pierced with cotemporary veins that they could not have ſupported themſelves, had not the ſubſtance with which they are filled been created at the ſame time as the mountain itſelf? I have uſed the expreſſion cotemporary, becauſe, if we can ſuppoſe that the fiſſures filled by theſe veins were formed in ſucceſſion, the objection which this fact would preſent to the theory of Werner would be by theſe means reſolved.

13. A. I muſt here repeat the 10th queſtion of Chap. II. How can it be conceived that all the metals and ſubſtances found in a vein ſhould have been diſſolved by the water of the ſea*?

14. Is it true that there are in Derbyſhire vertical veins of lead interſected ſeveral times by horizontal ſtrata of amygdaloides or loadſtone?

15. Are there found, in the neighbourhood of veins, ſtrata of the ſame mineral contained in theſe veins, and which ſeem to have been depoſited at the ſame time when the depoſits of the ſea filled the fiſſures occupied by theſe veins?

16. Is it well aſcertained that there are certain metals and certain kinds of ore found only in certain kinds of mountains?

* Or in the waters of the great ocean, which are ſuppoſed to have covered the whole globe of the earth. C.

tains? And, if this circumſtance be true, does it ariſe from the relative age of theſe minerals and mountains, or from the ſubſtance of the mountains favouring the precipitation of one kind of mineral more than that of another?

17. Is it true, as M. de Trebra ſays, that the richeſt veins, and the richeſt points of any vein, are found in the vertical line which correſponds with the loweſt part of the reſervoirs of the rain water, and never in the peaks and moſt elevated ridges? And, if this be well aſcertained, would it not prove that the veins had an origin poſterior to the grand revolutions which have given to the ſurface of our globe its preſent form, and that the metals have been depoſited in them by the meteoric waters?

18. Is it true alſo that the richeſt mines are found in mountains, the declivities of which are not ſteep*?

19. Are there inſtances of veins, entirely exhauſted, being again filled up with ore?

20. Does the production of metals depend on the influence of the ſun and climate? Are they more frequently found near the eaſtern or ſouthern, than the weſtern or northern faces of mountains?

21. Can we generaliſe the obſervation made in Siberia, Tranſylvania, at Mount Roſe, and in other places, that in gold mines the veins are richer near the ſurface of mountains than at a greater depth.

21. A. Is it generally true, that the veins are richer at their points of interſection than in any other place?

22. Is the inclination of veins ſeen more frequently contrary, than parallel to, the adjacent face of the mountain?

23. Does it ſometimes happen that the rock which forms the ſides (*neben-geſtein*) of the vein is as rich and even richer in metal than the vein itſelf; and would it thence

* As the Saxon authors generally ſay; becauſe the fact is true among them and in ſome other countries, while the caſe is not ſo elſewhere, and particularly in the Pyrenees. C.

 follow,

follow, that the metal arrives at the vein by filtering itself through these sides?

24. Is it true that, in mountains of granite, the grain of the granite is finer and the stone more tender in the neighbourhood of a vein?

25. Are there observed in any mine proofs that subterranean fires have contributed to its formation by subliming the metallic substances, or by melting them? In a word, are there seen there any traces of the action of fire?

26. In the greater part of mines do we not, on the contrary, observe proofs of the action of water in the situation of minerals and of their matrices; in their *druses* (groups of crystals), and in the state, form and nature of their crystallisation?

27. Does there prevail, at the bottom of mines, a heat superior to the mean temperature of the earth? And if such a heat exists in any mine, may it not be explained by that produced by the lamps; by the miners themselves; by some accumulations of pyrites, or some local reservoirs of water, without having recourse to a general cause or central fire?

28. Is it certain that, in general, veins decrease in thickness in proportion as they proceed to a greater depth, and terminate in such a manner that the fissures which contain them are closed at the bottom? Were this fact established, would it destroy the possibility of sublimations arising from the interior parts of the earth * ?

29. In mines which proceed by strata, to observe their nature, extent, thickness, inclination, and depth; their interruption by the veins that intersect them; their alternate swellings and constrictions, as well as the augmentation and diminution of their richness, and the signs which precede these changes.

* 28. A. Do there exist veins of from ten to twenty fathoms and more in thickness? or have not metalliferous banks or fissures between two different kinds of stone been taken for veins? C.

30. Whe-

30. Whether it be rare to find, under the form of ſtrata, other metallic mines than thoſe of copper, iron, lead, calamine, and manganeſe.

31. Whether the mines in ſtrata are generally poor near the ſurface of the mountain, and become richer the deeper they proceed.

31. A. Whether mines, where the metal is found in lumps or in a maſs (*ſtockwerke*), ought to be claſſed among thoſe in veins or thoſe in ſtrata *?

32. In coal mines to obſerve the nature of the coal; more or leſs compact; more or leſs rich in bitumen; more or leſs mixed with argil or pyrites.

33. To examine, in the coal, the traces of their origin; whether they have been formed of wood, turf, or marine plants †.

34. To obſerve whether there are found the remains of marine or terreſtrial animals.

35. The progreſs of the ſtrata: whether it be true that they often begin by deſcending in order to become horizontal, and afterwards to re-aſcend; and that they are thickeſt in the horizontal part, and give coal of a better quality ‡.

* 31. B. To obſerve alſo a third poſition of the ore, or ore found in the tranſitions (*ſtein-ſcheidung*); that is to ſay, between two kinds of ſtone of a very different nature; as between argillaceous ſchiſt and calcareous ſtone, between the ſame ſchiſt and compound rocks, &c. Not to confound this poſition of ore with real veins, nor with metalliferous banks, ore in ſtrata, and the *ſtockwerke*. C.

† 33. A. To diſtinguiſh carefully real coal from jet or foſſil coal (the *braun-kohle* of the Germans), and from coal earth, as well as from that ſubſtance known by the Germans under the name of *blend-kohle*. C.

33. B. To examine whether there is not found ſometimes in calcareous ſoil, fat, gelatinous coal; or whether there is never found but dry, friable coal. C.

‡ 35. A. To aſcertain whether there exiſts foſſil coal in veins, as is ſaid to be the caſe at Wehrau in Upper Luſatia. C.

36. Whether there are feveral ftrata, one above the other, with banks or other foffils interpofed. The quality and relation of thefe ftrata.

37. The nature and thicknefs of the ftrata of the earth or ftones under which the coal mine is found; the impreffions and other veftiges of organifed bodies found in thefe ftrata.

37. A. How can thofe who afcribe the origin of coal to forefts buried in the earth, explain the very thin ftrata of that foffil contained between banks of calcareous ftones, and which are repeated at different heights in the fame mountain? Does not this obfervation fhew that there are coal which have originated alfo from fuci, algæ, and other marine plants?

37. B. Ought we to fuppofe that all coals have been in a ftate of folution? What is the agent which diffolved them, and which may be called the mineralifer?

38. Though mines of rock falt are commonly found in ftrata, yet M. Fichtel affirms, that there are found in Tranfylvania enormous maffes of pure falt, compact, and without any appearance of foreign bodies. Thefe he confiders as of very ancient formation, and diftinguifhes them from thofe which are in ftrata between beds of argil and free-ftone mixed with fhells. Thefe important facts deferve to be thoroughly examined.

39. To afcertain the truth of an affertion made by the fame geologift, that thefe maffes of falt are furrounded by ancient volcanoes; and to determine whether we ought to believe with him, that this falt has been cryftallifed by the heat of thofe volcanoes which evaporated the water that held them in folution.

40. To examine, in the laft place, whether any of thefe maffes of falt appear to have been raifed up by fubterranean fires to a height greater than that at which they were at the time of their formation.

41. To

41. To examine the reafon of the fingular connection obferved between mines of falt or falt fprings and mountains of gypfum *.

[To be continued.]

IV. *Account of a large Tree in India. By Colonel* IRONSIDE †.

BY the fide of the Ganges, about three miles above the fortrefs of Allahabad, near the fmall pagoda of a goffeir *(fakir)*, I faw, on the 21ft of November 1777, four trees called *kulberich*; the trunk of one of which appeared of fo uncommon a fize, that I fent for a ftring to meafure its dimenfions, and found the circumference of it to be thirty feet ten inches. Its height is that of a pretty large beech, the rind or bark even, annulated and pulpy; and all the limbs fmooth and very large, but rather fcant of foliage; thofe very fmall branches which bore leaves being in clufters, fo that the tree, at fome diftance, feemed not unlike a ftem of the thick fpecies of *coralline*. The leaves are the fize of oak leaves, but not finuated, and of a light though not bright green; the fruit is of the fame colour, in fhape almoft conical like a pine, nine inches long, eleven inches and a half round the moft fwelling part, and with a foft velvet rind. Not being in bloffom at that feafon, I had no opportunity to obferve the flower. The fakir told me that there were only thofe four within 700 miles of the place; the feeds of them, which are fhaped like a kidney bean, and as large as a *caravanfa*, having been fent for by one of the

* And particularly of gypfum coloured by a red argil. To examine alfo why afphaltes is commonly found in the neighbourhood of falt-pits.

42. To obferve the different efflorefcence of the different falts formed on the rocks and the furface of the earth, in order to determine their nature.

43. To note alfo the nature, the abundance, and what may be difcovered in regard to the origin of mineral waters: to determine the temperature of them. C.

† From the *Oriental Collections*, Vol. I.

 emperors,

emperors, and ſown there. The groves and faſhion of the ground, as well as the fruit-trees, and a large ſtone wall about them, indicate the place to have been once a garden, and it is called to this time *Bejum-ke Baug*, or the *Queen's Garden.*

On my arrival at Patna, on the 2d of January 1778, I luckily met with a gentleman named Kerr, celebrated for his ſkill in botanical reſearches, who told me that the above-mentioned tree was of the ſpecies claſſed in the Linnæan ſyſtem under the name of *Adanſonia*, a deſcription of which is to be found in the ſixth edition of his *Genera Plantarum*, printed at Stockholm 1764, p. 352.

V. *Account of a Banian Tree in the Province of Bahar. By Colonel* IRONSIDE *.

NEAR *Manjee*, a ſmall town at the confluence of the *Devah* (or *Gogra*) and the *Ganges*, about twenty miles weſt of the city of Patna, there is a remarkably large tree, called a *bur* or *banian tree*, which has the quality of extending its branches, in a horizontal direction, to a conſiderable diſtance from its ſtem; and of then dropping leafleſs fibres, or ſcions, to the ground, which there catch hold of the earth, take root, embody, grow thick, and ſerve either to ſupport the protracted branches, or, by a farther vegetation, to compoſe a ſecond trunk. From theſe branches other arms again ſpring out, fall down, enter the ground, grow up again, and conſtitute a third ſtem, and ſo on. From the oppoſite pretty high bank of the Ganges, and at the diſtance of near eight miles, we perceived this tree of a pyramidical ſhape, with an eaſy ſpreading ſlope from its ſummit to the extremity of its lower branches, and miſtook it at firſt for a ſmall hill: we had no quadrant to meaſure its height; but the middle or principal ſtem is conſiderably higher, I think, than the higheſt elm, or other tree, I ever ſaw in England. The fol-

* From the *Oriental Collections*, Vol. I.

lowing

lowing comprife fome other of its dimenfions, which were taken with a cord of a given length :—

	Yards.	Feet.
Diameter of the branches from north to fouth	121, or	363
Diameter of ditto from eaft to weft -	125, or	375
Circumference of the fhadow of the extreme branches, taken at the meridian -	372, or	1116
Circumference of the feveral bodies or ftems, taken by carrying the cord round the outermoft trunks - - -	307, or	921

The feveral trunks may amount to fifty or fixty.

N. B. The dropping fibres fhoot down from the knots or joints of the boughs.

This tree, as well as the *peepel*, and many other large trees in India, is a creeper. It is often feen to fpring round other trees, particularly round every fpecies of the palm. The date, or palmyra, growing through the centre of a banian tree, looks extremely grand; and yet none of the European landfcape painters, who have delineated views of this country, have introduced this characteriftic object into their pieces. I have frequently obferved it alfo fhooting from old walls, and running along them. In the infide of a large brick-wall it lined the whole circumference of the internal fpace of it, and thus actually became a tree turned infide out.

Under the tree fat a *fakir*, or devotee. He had been there twenty-five years; but he did not continue under the tree throughout the year, his vow obliging him to lie, during the four coldeft months, up to his neck in the Ganges; and to fit, during the four hotteft months, clofe to a large fire.

VI. *On*

VI. *On the different Kinds of Cadmia, and particularly those of Zinc and Cobalt.* *By* I. I. BINDHEIM *of Moscow.*

[Concluded from Page 255.]

Of COBALT.

IT is scarcely a century and a half since people knew how to make use of cobalt ore. Brand, counsellor of the mines in Sweden, first proved that cobalt was a semi-metal, and that it possessed peculiar properties different from those of other metals. He defended his opinion against various objections that were made to it; but it is still believed by some, that it is a mixture of copper, iron, and arsenic: and this seems the more probable, as a fixed blue colour, fit for being employed in the arts and manufactures, is prepared with advantage at Vienna from iron and arsenic. This, however, does not place the circumstance beyond all doubt, for it still remains to be examined whether the arsenic and iron employed for that purpose be free from cobalt; and, until that be ascertained, the fact must be involved in uncertainty; for both, or at least one of them, may be mixed with cobalt.

Lehmann was of opinion, that the colouring matter of cobalt consisted of a fine alcaline earth combined with some particles of copper and iron; and he made experiments on this subject, by which he obtained blue glass. But from the description he gives of his experiments it does not appear sufficiently proved that ingredients free from cobalt were used for the mixture.

The reason why some may have been inclined not to ascribe the principle which colours smalt to a metallic substance may have been, that they employed for their experiments a cobalt ore free from arsenic, and did not apply a sufficiently strong heat, without which the regulus of cobalt is difficult to be fused, and not so easily separated: the principle which gives the blue colour to glass is, however, to be ascribed

afcribed certainly to the metal of cobalt, as has been placed beyond all doubt, and clearly proved by the experiments of M. Meyer, to be found in Sellers' Collections.

Some, on the other hand, have endeavoured to banifh cobalt from the number of metals; but no one will certainly any longer doubt of its being a peculiar metal, fince it is well eftablifhed, that fimple fubftances are properly confidered to be fpecifically different when they exhibit various properties which other bodies do not poffefs, and that every fubftance is confidered as fimple when it cannot be feparated into different principles, and be again formed from them. Now this is confirmed in regard to cobalt; and it is found that it not only poffeffes properties different from thofe of all other metals, but is itfelf a metal of a totally peculiar kind. Even though there be an analogy between iron, nickel, arfenic, and cobalt; and though, according to the fuppofed hypothefis, the regulus of cobalt is only a variety of iron, and that it is difficult, if not impoffible, to feparate it from cobalt; yet the latter ftill remains a metal of a peculiar kind.

The firft and principal refearches for difcovering cobalt mines were made in the Saxon mountains, and thefe procured to that country an opportunity of carrying on a confiderable trade with this production. Good cobalt ore, fit for colouring, is found at prefent, though not in fuch abundance, in Heffe, Wurtemberg, the Harz, Bohemia, Pruffia, Silefia, and Sweden.

As far as I know, pure native cobalt has never yet been found; what is commonly pretended to be fuch, is mineralifed by arfenic. It is found in an oxygenated ftate, and always combined with iron, and alfo mineralifed with carbonic acid; in vitrious cobalt ore, by the fulphuric and the arfenical acids; and to this belongs the fo called flowers of cobalt, found in tender reddifh cryftals: it is alfo found mineralifed by arfenic, with a little iron, in dull grey cobalt ore; by fulphur and arfenic, with iron, in white arfenical cobalt

cobalt ore; and by a little ſulphur, with abundance of iron without any arſenic, in ſulphurated cobalt ore.

When ſuch ore is treated in the fire, the arſenic evaporates, and the metallic and earthy particles remain behind, which, in order to be prepared for commerce, muſt be mixed with pounded quartz or ſand, afterwards moiſtened, and then packed up in caſks under the name of *ſaſlor* or *zaffera*. If very fuſible glaſs be melted with a little cobalt ore, and if the maſs be finely pulveriſed, it produces ſmalt, which, by waſhing, may be fitted for an article of commerce of different qualities and ſorted. This ſmalt, however, contains in general an impure regulus of cobalt, which often conſiſts of a mixture of cobalt, iron, arſenic, and nickel, and is called *cobalt ſpeiſe*. If you wiſh to obtain a pure regulus of cobalt, you muſt chooſe for that purpoſe a cobalt ore as free as poſſible from foreign metallic ſubſtances. You muſt then roaſt it carefully according to the proportions of ſulphur and arſenic which you find in it, and reduce it by adding carbonaceous matter to take up the oxygen, and a good alcaline flux at a ſtrong fuſing heat. If the cobalt ore employed contains biſmuth, and is free from nickel, the regulus of biſmuth will be found at the bottom of the reduced cobalt in a ſeparated ſtate. This regulus is not pure, and ſufficiently free from iron; but it may be brought to purity, though with trouble and a conſiderable loſs of the regulus of cobalt. To effect this, it muſt be calcined with borax, on a teſt, in the ſame manner as copper, until it is no longer attracted by the magnet. Some, however, are of opinion, that iron is not the only metal attracted by the loadſtone, and that it exerciſes an attractive power over the fineſt blue colouring regulus of cobalt: but there are well-grounded objections againſt this idea, for that effect takes place only when the latter is not ſufficiently freed from iron; and according to the experiments of Bergmann, a compoſition of one part of iron and three parts of cobalt is attracted by the magnet; but if the proportion

proportion of the iron be confiderably lefs, that effect is not produced.

The fpecific gravity of a regulus of cobalt, purified as much as poffible by the above method, is 7·700*; its colour is a pale greyifh blue, but it becomes fomewhat darker when expofed to the atmofphere: it is finely granulated on the fracture, and requires a ftrong degree of heat to be fufed, efpecially when no arfenic is prefent; and therefore it happens that it is fo difficult to extract the regulus by fufion from cobalt ore which contains no arfenic. It is not, however, volatile, like the greater part of the femi-metals; and does not inflame and evaporate, but when calcined becomes a blackifh oxyde.

When cobalt is pure, it diffolves in acids with a red colour; when it does not diffolve, it is a fign that it is prevented by fome foreign mixture: if the folution be green, it commonly implies the prefence of nickel.

With the vitriolic acid cobalt affords brownifh red cryftals; the nitrous acid diffolves it alfo of a red colour: by the muriatic acid regulus of cobalt is diffolved with difficulty, but its calx eafily diffolves. This folution is red when cold, but when expofed to a heat of 80 degrees becomes green; it fhoots into red cryftals inclining to blue: if thefe cryftals are diffolved in water, and a little of the muriatic acid be added, it produces that kind of fympathetic ink which becomes green when heated, and invifible when cold. The acetous acid diffolves the calx of cobalt alfo of a red colour. If fuch folutions are precipitated by volatile lixivious falts (ammonia), and the quantity neceffary for faturation be added, it is rediffolved of a dark red colour.

In the wet way the oxalic acid, and in the dry way iron, have the greateft affinity with cobalt. It combines with all metals except filver, lead, and bifmuth. Regulus of cobalt unites only weakly with fulphur, but is fully diffolved by fulphat of pot-afh.

* Bergmann Sciagr., but in his Differtation on Nickel he makes it 8·[illegible].

VII. *Singular Cure of a young Woman, effected by expelling from the Stomach, &c. the Larvæ of certain Insects.* By M. Odhelius *.

THE account of this ſingular caſe was tranſmitted to M. Odhelius, together with ſome of the larvæ, by M. Flank, ſurgeon of Carlſtadt, who, during the courſe of forty years practice, never ſaw any of the like kind diſcharged from the human body. The patient, who was ſeventeen years of age, and who for three years had been quite regular, became indiſpoſed in the year 1786, and complained of a violent pain and griping in her ſtomach, with a head-ache and confuſion in the morning, a burning in the throat, and great laſſitude. Theſe ſymptoms were leſſened after repeated eructation; but the diſorder ſtill increaſed. Mineral water with jalep powder was preſcribed, and the larvæ began gradually to be diſcharged; but as the patient did not find much relief, and as ſhe nauſeated jalep powder, aloe pills, with jalep reſin, and mercurius dulcis, were adminiſtered in its ſtead, and about a quart of mineral water each time: by which means theſe troubleſome gueſts were gradually ſo completely expelled, that the patient, in the courſe of a few weeks, was perfectly cured. The larvæ were tranſmitted to the Cabinet of Curioſities belonging to the Academy of Sciences. Profeſſor Wilke found, on examining them, that they were of the ſpecies deſcribed by Reaumur under the name of *Vers a queue de rat* †, and which belong to a kind of two-winged fly, called the Pendulous Fly, *Muſca pendula* L.; becauſe the larvæ are ſuſpended, as it were, by a long thread, which is their organ of reſpiration. Theſe larvæ, which the Profeſſor examined, were of a yellowiſh-brown colour, from four to ſix lines in length, with a tail of about the ſame extent; a cylindric body, from half a line to a line in thickneſs, cut

* From *New Tranſactions of the Academy of Sciences at Stockholm*, Vol. X.

† Memoires pour l'Hiſt. des Inſectes, T. IV. Mem. 11. p. 443.

acroſs

acroſs ſomewhat obliquely before, and conical towards the tail. As the patient, before ſhe fell ill, had uſed a great deal of milk and cheeſe, M. Wilke was of opinion, that ſome of the eggs of theſe flies had been conveyed into her ſtomach in the rind of the cheeſe.

VIII. *On the Signs exhibited by Animals which indicate Changes of the Weather, with Remarks on other Prognoſtications. By* M. Toaldo *.

THE fluids and ſolids of organiſed beings, and their animal machines, are conſtructed in ſuch a manner that a certain degree of motion puts them in a good ſtate, while an augmentation or diminution of it deranges and deſtroys that ſtate. The fluids, which by their nature are eaſily moved, as well as the fibres, which are highly ſuſceptible of irritation, are readily affected by changes of the ſurrounding atmoſphere, and ſuffer from their impreſſions, whether the air varies in its weight or qualities, or is changed in regard to its elaſticity. We find, among thoſe who are ſound and in perfect health, vivacity, good ſpirits, and great agility, when the air is pure and elaſtic; on the other hand, when the air becomes light and damp, and is deprived of its elaſticity, it throws the body into a ſtate of languor and debility. Valetudinarians, whoſe conſtitutions are delicate, or who are advanced in life, are much ſooner ſenſible of the impreſſions occaſioned by changes of the weather than thoſe who are ſtrong and robuſt. In general the ſenſes of men, who in their way of life deviate from the ſimplicity of nature, are coarſe, dull, and void of energy. Thoſe alſo who are diſtracted by a thouſand other objects, ſcarcely feel the impreſſions of the air; and if they ſpeak of them to fill up a vacuum in their miſerable and frivolous converſation, they do it without thinking of their cauſes or effects, and without

* From his *Meteorological Eſſays.*

ever paying attention to them. But animals which retain their natural inftinct, which have their organs better conftituted and their fenfes in a more perfect ftate, and which befides are not changed by vicious and depraved habits, perceive fooner, and are more fufceptible of the impreffions produced in them by variations of the atmofphere, and fooner exhibit figns of them.

Until the new difcovery of animal electricity little attention was paid to thefe figns, which were confequently afcribed to a certain natural prefcience. But as the electric matter iffuing from the earth diffufes itfelf through the atmofphere, it muft penetrate and agitate the frail machines in queftion; and as it carries with it vapours and exhalations of various kinds, thefe muft produce, on machines fo delicate, different fenfations, which make them move in a different manner; and, according as the received impreffion is agreeable or troublefome, they exhibit figns of joy or fadnefs; fend forth cries, or are filent; move, or remain at reft; as is obferved in all kinds of animals, without excepting man, when the weather is about to change.

In the laft place, internal and animal electricity, which in all probability is the agent of life and the grand fource of organic motion, muft be as much fubject to modifications as the external electricity, from which it acquires new force and activity by the vapours and humidity of the atmofphere, which abforbing the electric matter in abundance, or ferving it as a conductor, draws it off from the animal machine. Hence arifes that languor and debility which are experienced during wet weather and when the fouth winds prevail; and for the fame reafon the moifture which has penetrated the organs, at leaft thofe that are weak or have fuffered any hurt or injury, or been expofed to fome new agitation, produces uneafinefs and occafions pain. It is difficult to explain clearly and with precifion how all this takes place; that is, how the electricity is excited, and by what mechanifm exhalations and vapours affect animals, and produce

duce changes in their bodies, ſince we are not acquainted with the curious organiſation of the moſt delicate parts of theſe machines; but we can obſerve and perceive the progreſs and general conſequences of theſe phenomena, as well as of thoſe by which they are produced. The following are the common and familiar ſigns exhibited by animals, which indicate changes of the weather, and which are not taken ſo much from the agricultural poet, who firſt collected them, as from common obſervation:

1. When the bats remain longer than uſual abroad from their holes, fly about in greater numbers and to a greater diſtance than common, it announces that the following day will be warm and ſerene; but if they enter the houſes, and ſend forth loud and repeated cries, it indicates bad weather.

2. If the owl is heard to ſcream during bad weather, it announces that it will become fine.

3. The croaking of crows in the morning indicates fine weather.

4. When the raven croaks three or four times, extending his wings and ſhaking the leaves, it is a ſign of ſerene weather.

5. It is an indication of rain and ſtormy weather when ducks and geeſe fly backwards and forwards; when they plunge frequently into the water, or begin to ſend forth cries and to fly about.

6. If the bees do not remove to a great diſtance from their hives, it announces rain; if they return to their hives before the uſual time, it may be concluded that it will ſoon fall.

7. If pigeons return ſlowly to the pigeon-houſe, it indicates that the ſucceeding days will be rainy.

8. It is a ſign of rain or wind when the ſparrows chirp a great deal, and make a noiſe to each other to aſſemble.

9. When fowls and chickens roll in the ſand more than uſual, it announces rain: the caſe is the ſame when the cocks crow in the evening, or at uncommon hours.

10. Peacocks, which cry during the night, have a prefenfation of rain.

11. It is believed to be a fign of bad weather when the fwallows fly in fuch a manner as to brufh the furface of the water, and to touch it frequently with their wings and breaft.

12. The weather is about to become cloudy, and to change for the worfe, when the flies fting, and become more troublefome than ufual.

13. When the gnats collect themfelves before the fetting of the fun, and form a fort of vortex in the fhape of a column, it announces fine weather.

14. When fea-fowl and other aquatic birds retire to the fea-fhore or marfhes, it indicates a change of weather and a fudden ftorm.

15. If the cranes fly exceedingly high, in filence, and ranged in order, it is a fign of approaching fine weather; but if they fly in diforder, or immediately return with cries, it announces wind.

16. When the dolphins fport and make freqnent leaps, the fea being tranquil and calm, it denotes that the wind will blow from that quarter from which they proceed.

17. If the frogs croak more than ufual; if the toads iffue from their holes in the evening in great numbers; if the earth-worms come forth from the earth, and fcorpions appear on the walls; if the ants remove their eggs from their fmall hills; if the moles throw up the earth more than ufual; if the affes frequently fhake and agitate their ears; if the hogs fhake and fpoil the ftalks of corn; if the bats fend forth cries, and fly into the houfes; if the dogs roll on the ground, and fcratch up the earth with their fore-feet; if the cows look towards the heavens, and turn up their noftrils as if catching fome fmell; if the oxen lick their fore-feet, and if oxen and dogs lie on their right fide; all thefe are figns which announce rain.

18. The cafe is the fame when animals crowd together.

19. When

19. When goats and ſheep are more obſtinate and more deſirous to crop their paſtures, and ſeem to quit them with reluctance; and when the birds return ſlowly to their neſts, rain may ſoon be expected.

Other Signs which announce Changes of the Weather.

1. If the flame of a lamp crackles or flares, it indicates rainy weather.

2. The caſe is the ſame when the ſoot detaches itſelf from the chimney and falls down.

3. It is a ſign of rain, alſo, when the ſoot collected around pots or kettles takes fire in the form of ſmall points like grains of millet; becauſe this phenomenon denotes that the air is cold and moiſt.

4. If the coals ſeem hotter than uſual, or if the flame is more agitated, though the weather be calm at the time, it indicates wind.

5. When the flame burns ſteady, and proceeds ſtraight upwards, it is a ſign of fine weather.

6. If the ſound of bells is heard at a great diſtance, it is a ſign of wind, or of a change of weather.

7. The hollow ſound of foreſts; the murmuring noiſe of the waves of the ſea; their foaming, and green and black colour, announce a ſtorm.

8. Good or bad ſmells, ſeeming as if it were condenſed, are a ſign of a change of weather; either becauſe exhalations ariſe and are diſperſed in more abundance, which is a ſign of an increaſe of electricity; or becauſe the air does not diſpell or raiſe theſe exhalations, which indicates that the conſtitution of the atmoſphere is motionleſs, light, and void of claſticity.

9. When the ſpiders webs and the leaves of the trees are agitated without any ſenſible wind, it is a ſign of wind, and perhaps of rain; becauſe it denotes that ſtrong and penetrating exhalations ariſe from the earth.

10. Theſe ſigns are leſs equivocal when the dry leaves and chaff are agitated in a vortex, and raiſed into the air.

11. A frequent change of wind, accompanied with an agitation of the clouds, denotes a fudden ftorm.

12. A want or too great a quantity of dew being a mark of a ftrong evaporation, announces rain: the cafe is the fame with thick, white hoar-froft, which is only dew congealed.

13. If falt, marble, and glafs become moift fome days before rain; if articles of wood, doors, and chefts of drawers fwell; if the corns on the feet and the fcars of old wounds become painful; all thefe figns indicate that aqueous vapours are exhaled from the earth, and are no doubt directed by the electric matter, which diffufes itfelf then in greater abundance and penetrates every body. Hence it happens that ftones become moift, that wood fwells, and falt becomes deliquefcent by the moifture. When the ftones after being moift become dry, it is a fign of fine weather.

14. On the other hand, when the weather inclines to rain, the water is feen to diminifh in vafes and fountains, becaufe the humidity is then carried away by the evaporation of the electric matter.

15. It is certainly a furprifing phenomenon to fee the earth, after very long and very abundant rains, to be fometimes almoft dry, the roads quite free from dirt, and the hands to become arid and parched. This is a fign that the rain has not altogether ceafed, and denotes a continual efflux of electric matter, which being renewed carries with it, in the form of vapours, all the moifture that falls on the earth.

16. There is fometimes, however, a great deal of dirt even after a very moderate rain, which in that cafe is a fign of fine weather, becaufe it indicates that evaporation has ceafed. Dry ftones and moift earth announce fine weather; dry earth and moift ftones announce rain.

17. The winds which begin to blow in the day-time, are much ftronger, and endure longer, than thofe which begin to blow only in the night.

18. Weather, whether good or bad, which takes place in the

the night-time, is not, in general, of long duration; and, for the moſt part, wind is more uncommon in the night than in the day-time. Fine weather in the night, with ſcattered clouds, does not laſt.

19. A Venetian proverb ſays, that a ſudden ſtorm from the north does not laſt three days.

20. The hoar-froſt, which is firſt occaſioned by the eaſt wind, indicates that the cold will continue a long time, as was the caſe in 1770.

21. If it thunders in the month of December, moderate and fine weather may be expected.

22. If it thunders at intervals in the ſpring time, before the trees have acquired leaves, cold weather is ſtill to be expected.

23. If the wind does not change, the weather will remain the ſame.

Such almoſt are the ſigns of the variations of the atmoſphere; but I will not be anſwerable for the certainty of them all. Plutarch, in his Problems, where it is aſked why a horſe who has eſcaped from a wolf becomes fleeter, replies, that becauſe, by a ſingle action, but executed with great force and vigour, he has acquired a diſpoſition to running and a habit of ſpeed; or perhaps, becauſe he is naturally ſwift and agile: but he adds, perhaps neither of theſe is true. This obſervation, I am afraid, will apply to ſome of the vulgar prognoſtics of the preſent day. For example, we are told, that it is a ſign of fertility in any year when a fly is engendered in an acorn of that year; and that it is the ſign of a peſtilential year, if there iſſues from it a ſpider. Should the reaſon be aſked, it might be replied, that neither of theſe is true. I might venture to ſay as much of thoſe popular tales in regard to certain critical days of the month; yet we muſt ſtill have ſome reſpect for popular proverbs, which are often founded on obſervation and reaſon. Thus it is ſaid, that if it rains on the 3d of May, the day of the Holy Croſs; or on the 23d of April, St. George's day; or the

15th of June, St. Vitus's day, &c.; in the firſt caſe the nuts will be ſpoiled; in the ſecond, the figs; and in the third, the grapes. All this may be true to a certain degree, that is to ſay, when it rains for a certain number of days about theſe periods; becauſe, if rain falls at the time when fruit-trees are in bloſſom, it carries off the fecundating farina, and by theſe means renders them barren.

In regard to the general qualities of the ſeaſons, and their influence, attention may be paid to the following ſigns:—If the earth and air abound with inſects, worms, frogs, locuſts, &c.; if the walnut-tree has more leaves than fruit; if there are large quantities of beans, fruit, and fiſh; if the ſpring and ſummer are too damp; if hoar-froſt, fogs, and dew come on at times when they are not generally ſeen, the year will be barren: the oppoſite ſigns announce fertility and abundance. Animals ſeem alſo to foreſee and prognoſticate fertility or barrenneſs: it is ſaid that when the birds flock together, quit the woods and iſlands, and retire to the fields, villages and towns, it is a ſign that the year will be barren.

A great quantity of ſnow in winter promiſes a fertile year, but abundant rains give reaſon to apprehend that it will be barren. A winter, during which a great deal of ſnow and rain falls, announces a very warm ſummer. It is generally believed that thunder and ſtorms in winter prognoſticate abundance, becauſe they fertiliſe the earth. When the ſpring is rainy, it produces an abundant crop of hay and of uſeleſs herbs, but at the ſame time a ſcarcity and dearth of grain. If it is warm, there will be plenty of fruit, but they will be almoſt all ſpoilt. If it is cold and dry, there will be few fruit or grapes, and ſilk-worms will not thrive. If it is only dry, there will be few fruit, but they will be good. In the laſt place, if it is cold, the fruit will be late in coming to maturity.

If the ſpring and ſummer are both damp, or even both dry, a ſcarcity and dearth of proviſions is to be apprehended.

If

If the fummer is dry, there will be little corn: difeafes will alfo prevail; but they will be more numerous if it is warm. If it is moderately cold, the corn will be late; but there will be a great deal of it; and the feafon will occafion few difeafes.

A fine autumn announces a winter during which winds will prevail: if it is damp and rainy, it fpoils the grapes, injures the fown fields, and threatens a fcarcity. If it be too cold, or too warm, it produces many maladies. A long feverity of the feafons, either by winds, drought, dampnefs, heat or cold, becomes exceedingly deftructive to plants and animals. In general, there is a compenfation for rain or drought between one feafon and another. A damp fpring or fummer is commonly followed by a fine autumn. If the winter is rainy, the fpring will be dry; and if the former is dry, the latter will be damp. When the autumn is fine, the fpring will be rainy. That this alternation is in general verified may be feen in a Journal carried on for forty years, and formerly edited by M. de Poleni.

IX. *On the Effects of Oil in Cafes of the Bite of Serpents; republifhed from the Charleftown (South-Carolina) City Gazette**.

Meffrs. FRENEAU and PAINE,

I READ with pleafure, in your paper of the 21ft of November, " fome fhort directions for the cure of the plague," compofed from a fmall pamphlet lately publifhed by Count Berchtold at Vienna, by the ufe of *fweet olive oil.*

To take off the fharp edge of misfortune, or to meliorate the condition of man, is a godlike employment. Count Berchtold will be defervedly claffed by the philanthropift among the benefactors to mankind.

In great cities, particularly in London, a number of per-

* From the *American Medical Repofitory.*

ſons procure their livelihood by catching vipers. They are employed by chemiſts, apothecaries, &c.

I remember, ſome years before leaving England, to have read in the Philoſophical Tranſactions of the Royal Society in London, a curious circumſtance relative to one of theſe viper-catchers.

A member of the ſociety had received, caſually, information that a man engaged in this buſineſs was frequently bitten, and that he cured himſelf by *ſweet olive oil*. After conſiderable inquiry, the viper-catcher was found, and the queſtions aſked, whether he did cure himſelf by the oil? and whether he was willing to gratify a number of gentlemen of the fact? The man anſwered affirmatively to both queſtions. Accordingly, a moſt numerous meeting of the Royal Society was convened, compoſed of a conſiderable number of the nobility, &c. The viper-catcher attended, accompanied by his wife, with a large viper; and laying his arm naked to the ſhoulder, ſuffered the irritated reptile to ſtrike, which it did very forcibly. His wife permitted the poiſon to operate till her huſband's head, face, and tongue were greatly ſwelled, his arm and face alſo very black, and his ſenſes much affected, when he applied the oil, by pouring a ſmall quantity down his throat, and bathing the part bitten. The man gradually and ſoon recovered.

This circumſtance being ſtrongly impreſſed upon my mind, and knowing that the poiſon of an Engliſh viper is conſidered in that country the moſt ſubtile in nature, determined me to try its antidotal power in the bite of the rattle-ſnake, the firſt opportunity which ſhould offer, on my retirement from Charleſtown to the back country, now called Pendleton County. I was alſo particularly impelled to make the trial, from a conſideration of the newneſs and wildneſs of the country, and the number of my family, beſide which there were hardly a dozen more in the country. This was in the year 1786.

In about a month after my arrival, a perſon in full ſpeed

came to my camp, and moſt urgently begged to know if I could aſſiſt a man who had juſt been bitten by a very large rattle-ſnake. Although I lamented the misfortune, I rejoiced at the opportunity it offered to aſcertain fully the property of olive oil as an antidote to this deadly poiſon; accordingly I put a phial of oil in my pocket, and mounted the meſſenger's horſe.

When I arrived at the unfortunate man's cabin, he ſtruck me as the moſt frightful object I had ever beheld. His head and face were prodigiouſly ſwelled, the latter black; his tongue proportionably enlarged, and out of his mouth; his eyes as if ſhooting from their ſockets; his ſenſes gone, and every appearance of immediate ſuffocation. He had been ſtruck on the ſide of the foot, about the middle, in the hollow.

Immediately, but with great difficulty, I got down two table-ſpoons full of oil. Its effect was almoſt inſtantaneous, and aſtoniſhingly powerful in counteracting the poiſon, as appeared by the ſtrong though quick convulſions that followed. In about thirty minutes it operated ſtrongly, both emetically and cathartically; after which the ſwelling of the head, face, &c. gradually abated, and the tongue began to aſſume its place. In about two hours he was ſo far recovered as to be able to articulate, and from that time recovered faſt. The oil, inwardly taken, and applied to the foot and leg, both exceedingly ſwelled, did not exceed ſeven or eight ſpoons full.

The number of caſes, of a like nature, in the courſe of twelve years, has been conſiderable; in all which, olive oil has proved itſelf to be peculiarly adapted and fully adequate to the worſt of caſes, if timely applied. It is a remedy which every perſon may command (may have at hand when others cannot be procured), and ought not to be without; indeed, many cautious people here carry a ſmall phial of oil conſtantly about them. It has alſo been uſed with equal ſucceſs when horſes, cattle, and dogs have been bitten. Thus

is

is the mind relieved from terror in thoſe whoſe occupation ſubjects them to the bite of the ſnakes, from a well-grounded confidence in the certain efficacy of the oil, and to which every one may have inſtant recurrence.

The caſe, I am informed, has occurred, where the oil ſucceeded when given to a woman bitten by a mad dog, under ſtrong ſymptoms of hydrophobia; but at preſent I am not ſufficiently in poſſeſſion of particulars to warrant its communication.

I can hardly excuſe myſelf of criminal neglect in having ſo long omitted to make thus public this ſovereign antidote to the worſt of animal poiſons. The knowledge of the efficacy of the olive oil is abundantly diffuſed in this county, and partially in ſome of the adjoining counties.

The inſertion of the foregoing particulars in your City and Carolina Gazettes, muſt make its invaluable properties generally known.

With great eſteem, I am, &c.

Pendleton County, July 4, 1798. J. MILLER.

X. *Thoughts on Deafneſs; with a new Mode of making Deaf People hear. Written* 15*th December* 1798, *by* D. WHYTE, M.D.

His Majeſty's Ship Atlas,
Torbay, 9th Auguſt 1799.

SIR,

HAVING ſeen in a late newſpaper an account, copied from your Magazine, of a new mode of conveying ſounds for the benefit of deaf perſons, propoſed by Profeſſor Blumenbach, I have extracted from my Medical Diary what I wrote ſome months ago on this ſubject.

As my ideas were formed without any knowledge of the German diſcovery, you will oblige me much by giving them a place in your very valuable Miſcellany.

I am, Sir, your humble ſervant,

D. WHYTE.

The Editor of the Philoſophical Magazine.

IT

IT has been a general remark, that deaf people ſpeak in a very low tone of voice, while they themſelves conceive that they ſpeak very loud. It is ſuppoſed that the deaf perſon, not being ſo eaſily affected by ſound, anſwers in what he believes to be the proper and correſponding pitch.

I came down laſt night from London to Goſport in the ſtage-coach: one of the paſſengers, a woman, was extremely deaf. A few weeks before, I had travelled in a ſimilar vehicle with an unentertaining companion of the ſame kind. My attention has been thereby turned to the ſubject; and I am led to make the following remarks:—

For that deafneſs ariſing from impaired excitability of the organ of hearing, properly ſo called, I know of no remedy: I confine what I have to ſay to that ſpecies of it which is occaſioned by a diſeaſed ſtate of tympanum, or the external meatus.

In either of theſe laſt caſes ſounds communicated by the external ear appear to be of a lower pitch than in reality they are; while, if the Euſtachian tube continues permeable, thoſe communicated through the mouth appear higher and louder than uſual. Even where the ear and all its parts and paſſages are in health, ſounds communicated through the mouth are more perfect than thoſe which paſs through the external meatus. This, perhaps, is occaſioned partly by the concavity of the mouth, and partly by the ſolidity of the teeth. In perſons whoſe tympanum, or whoſe external meatus is diſeaſed, it is probable that the ear, from habit, becomes more ſenſible to the vibrations of ſound communicated through the Euſtachian tube, than, without ſuch a circumſtance, it otherwiſe would be.

Sound being more eaſily communicated through the medium of ſolid than of rare bodies, I apprehend that a long wire held in the mouth would be much more ſerviceable to ſuch a deaf perſon, than the largeſt trumpet applied to the external ear.

It poſſeſſes alſo the advantage of being extremely portable, and

and may at all times be used without inconvenience, and almost without being observed.

I shall certainly make trial of it in the first case that occurs.

XI. *On the Assaying of Ores by Fusion. By Mr.* DAVID MUSHET *of the Clyde Iron Works. Communicated by the Author.*

MY Paper in the Number for July concluded with a table of the proportions requisite to obtain, from all the various iron-stones, an accurate assay; the perfection of which is always indicated by the superior transparency of the flux, and the super-carbonation of the metallic button. By scrupulously following these and similar proportions as the exigencies of the ore may point out, crude iron will always be obtained of the finest quality, carbonated beyond whatever is produced in the large way of manufacture, and its surface covered with a beautiful carburet of iron, either in small shining specula, or in the state of a thin membrane. By a slight gradation of change in the proportions of the component parts of the flux, the metal of the same iron-stone may be made to pass through all the inferior states.

Since, then, all iron-stones in the assay-furnace may be made to give out their iron at pleasure, of all the various qualities, it is surely erroneous to assert, that such and such iron-stones cont in such and such qualities of iron; that this one affords metal of the finest quality, while that, on the contrary, yields iron fit only for forge-pigs or ballast; yet this is the universal language in the manufactory. In this, as in many instances, we accommodate the language to our ideas, rather than our ideas to truth. The suffrage of prevailing custom has imperceptibly associated with our ideas many absurdities which we are afterwards ashamed to acknowledge, and which darken the gleam of truth, or render it

it apparently ridiculous, merely because it is at variance with our prejudices. Where science guides not the manufacturer, or is scorned by him, his train of reasoning, though far from being just, is short; it is fitted to the narrow culture of his mind, and consonant to a barbarous nomenclature of received usage*.

In order to elucidate still farther how much the quality of the iron is dependent upon the proportions of the mixtures, in combination with, or given to the ores, let a determinate quantity, say an ounce, of the oxyde of pure malleable iron be taken;—this we are physically certain contains no mixture except oxygen existing in quantity proportioned to the stage of oxydation, the quantity being ascertained by its degree of obedience to the magnet; when the quantity of oxygen given

* I cannot resist noticing one instance, prevalent at iron-works, of that blind reverence to the opinion of our predecessors, whose sources of knowledge must necessarily have been few and contracted. When super-carbonated crude iron is run from the furnace, it is frequently covered with a scurf, which when cold is found to be a coating of plumbago (carburet of iron) remarkably brilliant; sometimes in small specks, and at other times in large flakes: this substance is universally denominated *sulphur*, and, as the most expressive adjective for that quality, we say that the iron is *sulphury*. There are not, perhaps, two substances so opposite in their degrees of inflammability, or so widely different in their properties, as sulphur and plumbago; the existence of the latter almost wholly supposes a total absence of the former: yet, such is the want of investigation, or the slightest momentary reflection, that an indolent belief is passed as to the presence of a substance diametrically opposite to that which is expressed. *Sulphur* has hitherto been the philosopher's stone of the iron manufactory; to its presence is attributed the production of bad iron—when the metal is in its most valuable state, it is also *sulphury*;—it prevents cast iron from becoming malleable; and if *sulphur* were altogether absent, hard or white cast iron could not be produced. If cast iron is found coloured, it is by the *sulphur*; is it crystallised and coloured, then it has sulphur to excess; should it have lost its strength, or have become loose in the fracture by an excess of shrinkage in large castings, still it is by the agency of sulphur: in short, in every process in the manufacturing of iron, sulphur explains the whole phenomena! it is execrated in one process, and anxiously looked for in another.

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to it, by the decomposition of water, exceeds 25 *per cent.* few traces of magnetic attraction are perceptible:—introduce this oxyde into a covered crucible, without any addition, and expose it to a violent degree of heat for 40 minutes, (longer in proportion to the quantity,) a button of highly oxygenated crude iron will be obtained: if the heat is continued longer than is necessary to effect this, a small mass of malleable iron will be found occupying the bottom of the crucible. The produce in either case will be short of the real quantity of metal contained in the oxyde. When oxygenated crude iron is obtained, the ore from which it is produced, to use the common phraseology, is said to contain *bad iron.* That this has no relation to truth, will be seen by taking another portion of the same oxyde; let it be mixed either with chalk or lime, and a little bottle-glass, to constitute fusibility, and exposed to a similar degree of heat with the former; the whole contents in iron will then be found revived, and occupying the bottom of the crucible in the state of fine carbonated crude iron. Here then is a complete alteration in the quality of the metal, though obtained from the same ore; for we cannot consider iron combined with oxygen, to which earthy bases are given, in any other light than that of an ore. Again, let a portion of mixture, exactly similar to the last, have added to it double or triple its weight of bottle glass, and subject the whole to an equal heat with the former experiments, nearly a complete revival of all the metal will be found to have taken place; its quality, however, will be highly oxygenated and brittle. Such experiments clearly demonstrate, that the various qualities of crude iron are entirely owing to the mixtures in the ore, and their treatment; and that iron, considered as a simple metallic substance, is the same in point of quality in all ores.

If iron was originally formed in a metallic state, its property of decomposing water, whether casually exposed to a moist atmosphere, or removed at various depths from the surface, furnishes an hypothesis as to the primitive principle

of iron ores; that part of the water—by far the greatest—which remained undecomposed, would serve as a medium, or vehicle of suspension, and conveyance to the oxyde; this again, in its turn, would be deposited either at the fountain-head, or at a greater or lesser distance from it, according to the affinities exerted upon it by other substances with which it might come in contact. Corresponding with this supposition, we commonly find those ores which are formed in vertical masses or knobs, approached by a great number of small veins occupying the smallest fissure or crevice in the rock. Time, and the re-action of additional water and acids, would a second time carry off a portion of the ore in chemical union; this, by the exertion of new affinities, would become precipitated, and mixed with the suspended earths, to form regular strata of iron-stone. To such a primary and secondary agency of formation may be attributed the general superior richness of ores found in irregular vertical masses, to that of iron-stones. The same cause will also explain why more determinate qualities of iron are obtained from primitive ores, than from those of a secondary formation. In the former, the mixtures are commonly fewer, and the quality of the malleable iron more decided; in the latter, the quality of the metal is less certain, and more various, from the mixtures being more numerous. Hence we may also trace the reason of the superior qualities and marks possessed by some of the foreign fabrics over each other, where the same fuel has been used, and the same course of manufacture followed.

Having so far considered crude iron, in regard to its fusibility, and the facility with which it becomes changed into various degrees of carbonation or oxygenation, constituting a variety of qualities most pointedly distinguished in commerce, and in which the metallurgist discovers widely different properties and characteristic forms; I shall next proceed to mention in what manner strength may be given to any quality of crude iron which may probably be obtained

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by the fuſion of an ore, and from what ſource this property is derived.

Upon a former occaſion I have mentioned that iron, obtained from argillaceous ores, poſſeſſed a degree of ſtrength beyond that obtained from the other genera. This truth daily preſents itſelf to our obſervation in the large ſcale of manufacture; and however erroneous the reaſoning of the manufacturer as to the cauſe, yet ſo evident are the conſequences produced, that we muſt immediately attribute them to ſome ſource beyond the caſualties of operation in the ſmelting furnace. In the explanation of this fact, as on the degrees of oxygenation and carbonation in general, the manufacturer has recourſe to the exiſtent nature of the iron in the ore, and denominates the metal contained in ſuch and ſuch an ore to be "ſtrong, coarſe, ill-melting iron;" or "weak, tender iron, poſſeſſing no body." That iron-ſtones and ores yield, in the operation of ſmelting, different qualities of crude iron, as to ſtrength, is an undeniable fact; and that the ſame variety attaches to iron when converted to malleability is a truth daily evinced in our forges: yet theſe facts by no means entitle us to conclude, without farther inveſtigation, that theſe varieties of ſtrength are the hereditary property of the priſtine formation of the metal. This inference accords with a haſty view of the matter, and a bare comprehenſion of effects, without tracing to its ſource the modifying principle of the whole. The theory which I have adopted, and which in every ſtep I have found ſupported by numerous experiments, upon different ſcales, and by a long courſe of practical obſervation, explains to me, with much more eaſe and harmony, the whole phenomena of quality in ores and iron-ſtones.

To illuſtrate that part of my theory relative to ſtrength, let the preceding experiment, wherein carbonated crude iron was produced from the oxyde of pure iron, be repeated with the addition of a little pure clay. If the clay added be half the weight of the lime alſo uſed, the iron will be found,

when

when subjected to the gauge, much superior in strength; and if the experiment be accurately performed, the metal will be but a little reduced in point of carbonation. The following proportions will give accuracy to the result:—Oxyde of iron, 4 parts—Lime, 2—Clay, 1—Glass, 3 = 10 parts. By mixing clay with the flux in all experiments, the strength of the crude iron is improved. This point may be urged so far as to form, by an extra-addition of clay, a flux of difficult fusion; in which the iron becomes suspended in globules, which are partially malleabilised apart from each other. Crude iron, obtained with a superior mixture of clay, in all its stages of quality, possesses a greater degree of strength than iron from calcareous iron-stones. Iron from argillaceous iron-stone is reckoned strongest when carbo-oxygenated; that extracted from calcareous iron-stone is reckoned to possess most strength when oxygenated, mottled. I would far exceed the limits of the present communication, were I to enter fully into this curious subject, and particularise the different results obtained by the fusion of ores with different earths in various proportions: all my experiments have fully proved to me, that originally the quality of the iron, simply considered, was the same; that, as it underwent change by decomposition and new combination, it became united to foreign substances, possessing widely different properties; and which mixture, by a general fusion, imparts to the metal various properties, seldom homogeneous, but frequently otherwise: in short, that the numberless mixtures with which it is combined are not neutral in fusion, but convey an alteration to the quality of the reduced iron. I hope to resume this subject when my experiments will be more extended by the examination of a vast variety of iron-stones, and shall then point out the consequent effects of their application to the manufacture of cast and malleable iron.

The assaying of primary ores comes next under consideration. These, I have already said, possess a much greater diversity of external character, as well as internal variety, than

 those

those of iron-stone. When assayed with a vitreous flux, either of salts, alkalies, or silex, the results are rendered very uncertain and erroneous: when pot-ash, tartar, &c. are used, the crucible is often destroyed, and the compound entirely lost: when bottle glass and a mixture of these are used, the scoria formed is so very black and ponderous as to give the most presumable indication of the secretion of metallic oxyde: this is afterwards verified by fusing the mass with a mixture of dried chalk and charcoal, a globule of metal will be obtained, which evinces the richness of the scoria; this, having lost its colouring principle (the metal), becomes clear and transparent. The results from these ores by fusion afford various products, and lead to different conclusions: I shall mention several of them.

The Cumberland iron ore, when introduced into a crucible without any additional mixture, fuses easily, and forms an opaque scoria, internally of a black colour, but towards the surface covered with fine shades of brown: this arises from a partial oxygenation of the semi-revived metal while cooling, and is often injured by a fresh combination of oxygen. If the crucible remains sound, and the melted mass is kept in a state of extreme division for an hour, a considerable quantity of metal will be found precipitated, but so highly oxygenated as to shiver to pieces if exposed to air before it is entirely cooled. If, when the crucible is taken from the furnace, it be slightly inclined to one side, and the vitrified fluid entirely removed from the surface of the metal, a violent deflagration will immediately ensue, the ejected globules will be thrown three feet upwards from the mouth of the crucible: if the quantity of metal does not exceed 500 grains, it will totally disappear, except a rough dark-blue oxyde in the bottom of the crucible, not above 1-4th of the original weight. The metal thus oxydated will be found in small spherules of a blackish colour, and spongy around the spot occupied by the crucible.

This curious appearance is in fact a combustion of iron

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by oxygen gas, furnished by the decomposition of atmospheric air: it is an operation which the accurate observer may daily see manifested in almost every department of the foundery and forge. By a just comprehension of it, and a proper appreciation of its effects, we have a key for the elucidation of the source and action of many facts long wrapped in mystery, or which have been explained upon principles destitute of stability, and unallied to the fundamental operations of truth.

In place of withdrawing the crucible immediately upon the separation of the crude iron, were it to remain for an hour longer under an inferior degree of heat, so as to consolidate the metal without again fusing it, then the whole mass would be found malleable; the scoria light and porous. In one of my experiments upon the hæmatites variety, I obtained from 1 lb. averdupoise, or 7000 Troy grains, an ingot of fine malleable iron weighing 4486 grains; a produce equal to 64 *per cent.* *

An oxygenating flux was however used, and nearly the whole contents in iron previously revived. In experiments without the addition of a flux, the transmutation from cast to malleable iron is shortened, but the produce is not more than 5-8ths of the intrinsic contents of the ore. Even this process may be considerably shortened by removing the covering of vitrified earths floating upon the surface of the metal: thus the small portion of the carbonaceous principle constituting fusibility is almost instantly carried off by the combination of oxygen; the metal loses its fluidity, becomes thick and clotted, and more speedily passes into the malleable

* This might be adduced as a proof that crude iron contains more parts congenial to malleability than is generally admitted, or than is manifested in the operation of converting it into malleable iron at the forge: the loss there has already been mentioned to amount to from 30 to 50 *per cent.* of real metal; in this assay, however, the produce in malleable iron was only 4,5 less than when accurately assayed, and rich carbonated crude iron was obtained; in which, too, the carbon constituted a part of the weight.

able ſtate. In this proceſs the quantity of malleable iron obtained is ſtill leſs than in the two former: the ſurface of the metal being expoſed by the removal of the ſcoria, oxydation takes immediate effect; and whilſt malleability is pervading the under ſurface of the metallic button, the upper one becomes reduced to a blackiſh blue oxyde. In this operation a ſtriking proof is afforded of the great affinity which oxygen has, in high temperatures, to caloric. Were the ſurface of ſuch highly oxygenated crude iron expoſed, while fluid, to atmoſpheric air, at an ordinary medium, for 1-6th of the time, its whole metallic properties would be completely deſtroyed: in the preſent inſtance nearly one-half of the metal is preſerved, although its ſurface is expoſed to the action of a violent current of gas, ignited to the higheſt pitch of whiteneſs *. In the proper aſſay of this ore I have found all the varieties

* I have frequently obſerved, in experiments with pretty deep crucibles, where the moſt violent heats were excited, and where the fluid metal had aſſumed a whitiſh-blue colour ſomewhat inclining to azure, that the quantity of oxyde formed was imperceptible, and never viſible while the heat was continued of equal intenſity; when this agent became leſs urgent, the ſurface of the metal became oxydated as uſual. When a regulus of crude iron thus expoſed was wiſhed to be obtained free from oxydation, a little dry charcoal was introduced into the crucible ſo as to cover the regulus; this prevented the action of the air from taking effect while cooling, and preſerved the button ſmooth. During ſuch expoſures, when no oxyde was produced, I have noted a loſs of metallic parts equal to 5.7, or 10 *per cent.* when the ſpace of time did not exceed one hour. Among ſeveral conjectures reſpecting the cauſe of this deficiency in weight, and real abſtraction of metal, the two following have with me moſt weight. 1ſt, Either the metal deflagrates in ſmall particles, which are thrown out of the crucible in ſparkles, made inviſible by the tranſcendent brightneſs of the ſurrounding heat: Or, 2d, that in conſequence of the fluid metal being expoſed to ſuch a great degree of heat, in contact with oxygenous gas, part of it becomes acidified, and forms the ferric acid. The truth of this laſt ſuppoſition will not eaſily be aſcertained, ſince it will be difficult to conſtruct an apparatus capable of receiving or containing it, ſhould it prove to be an elaſtic fluid: it is, however, conſonant to the doctrines of the new theory, and the poſſibility of the exiſtence of the ferric acid is by no means excluded. The diſſipation of carbon

varieties susceptible of various degrees of carbonation: for the most part I have used chalk and charcoal for the reduction of the ore into carbonated crude iron. In the hæmatites variety, for 1 lb. averdupoise I have commonly added 6 oz. dried chalk and 3-4ths oz. of charcoal; and for the splinty blue ore also a similar mixture. From both of these I have obtained the richest sort of crude iron. In the manufactory these varieties are always reckoned to produce the hardest and most infusible qualities of crude iron: when the

carbon or oxygen will not nearly explain this phenomenon, as they exist in much less proportion; and while the iron remains in a crude state, the latter accumulates in proportion as the former becomes expelled. Besides, a greater product in malleable iron is obtained by following the precautions formerly mentioned, than even of cast-iron when thus exposed. Now, as malleable iron is free from all mixture, or at least is malleable in proportion as it is unalloyed, it is obvious that the deficient weight is not made up of either oxygen or carbon. In the exposure of one particular button of crude iron, which lost 9½ *per cent.* the surface was agitated in an uncommon and most beautiful manner; a rapid motion from the extremity of the circumference to the centre of the fluid mass took place; the motion seemed entirely rotatory, and peculiar to one common axis. The metal itself was of a blueish green colour, and emitted from its surface an azure-coloured gas, which preserved a distinct form and colour from the common flame. This appearance first led me to suppose the presence of the ferric acid, by which means the loss of weight, when no oxyde was visible, would be easily accounted for. To try, so far, the justice of this conjecture, I exposed tin, lead, and zinc, in different alloys of these metals, to white heats, and found them dissipate in a much shorter time, and with a greater discharge of gas from their respective surfaces. The same effect was more speedily produced by introducing the pieces upon the surface of hot melted crude-iron. Zinc, in this experiment, inflames instantaneously; explodes with considerable violence, and with the disengagement of a blueish flame. Its known inflammable property may add little strength to this hypothesis; but the dissipation of lead and tin, without any residue, would also lead to a supposition of the plombic and stannic acids being formed by a complete saturation of oxygen. The latter, being found formed by nature in a crystalline form, does not entirely contradict this idea; for a difference in the dose of oxygen, and of temperature, must alter the result.

metal is subsequently manufactured into bars, it is stated at different places to produce cold and hot short iron.

The kidney ore will admit of a diminution of chalk, and a small addition of glass; 1 lb. averdupoise of this variety will be accurately assayed with the addition of 5 oz. chalk, 1 oz. of glass, and 3-4ths oz. of charcoal. The same proportion of mixtures will also accurately reduce the small pieces of this ore, commonly of a soft, greasy consistency, mixed with small fragments of the hæmatites and kidney, and will give out the iron which they contain super-carbonated. A mixture of this soft ore with kidney is preferred to the richer varieties at the iron manufactories. The Lancashire ore chiefly consists of this compound, and the poorer in iron has always a decided preference given it at the blast furnace.

The stratified iron ore of the island of Islay is of most difficult fusion when treated without any addition. It fuses into a blackish green ponderous mass, and, even exposed to the highest heats, lets fall but a small share of its iron. The quality thus obtained is in the highest degree oxygenated; its fracture is partially crystallised in lines which converge towards the upper surface of the button, similar in crystallisation to the fracture of zinc. A regulus thus obtained, when divested of its scoria, and properly exposed to the action of the ignited gas, soon loses its fluidity, and passes into the state of strong malleable iron. If this operation is performed upon a large quantity, without agitating or turning the mass, the upper surface of malleable iron will early acquire the cold short quality, and will be subject, at the same time, to an uncommon waste by the rapid oxydation of its parts. In assaying this ore for the production of carbonated crude iron, the results are obtained with considerable difficulty; seldom perfect till the second or third experiment. This is chiefly owing to the great variety of quality in the stratum, two pieces seldom being alike either in appearance or in reality. The inferior masses yield from 44 to 48 *per*

cent;

cent; and the superior qualities I have found as rich as 56 to 61 *per cent*. To obtain carbonated crude iron from the richest varieties of this ore, add to 1 averdupoise lb. of it 7 ounces of dried chalk, 3 of bottle-glass, and 1 of charcoal. This mixture will produce soft crude iron, possessing great strength, and an uncommonly large crystallised grain. The poorer qualities require an additional quantity of calcareous earth, to restore the equilibrium lost by the substitution of silex in place of iron. This ore had a trial in the large way at Clyde Iron Works, but was found to yield *bad* iron with the *usual* proportion of fuel.

Opposite in its quality and results is the beautiful ore of the island of Elba. This, when presented to a requisite proportion of carbonaceous matter, to take up its oxygen, not only clears itself of this hurtful mixture, but also takes up a considerable portion of carbon, which, in fusion, becomes united to the metal, and constitutes it perfectly carbonated. In experiments with this ore, I found that when 2 ounces of it were treated with $2\frac{1}{2}$ oz. chalk, $\frac{1}{2}$ oz. bottle-glass, and $\frac{1}{4}$ oz. charcoal, the mixture was with difficulty reduced to a white glass; which at no time had been sufficiently divided to allow a general gravitation to the many globules of beautiful carbonated iron thus separated. In fusion, therefore, *per se*, the metal precipitated becomes greyish, and, in many instances, affords similar results to a pure calcareous iron-stone; with this principal difference, that it abounds with nearly a double quantity of metal, whose tendency to become carbonated is no-ways inferior to any iron-stone of that class. A smooth carbonated regulus will be obtained from this ore, by using the following proportions: Ore in a raw state, 2 ounces; chalk, 2 ounces; bottle-glass, $1\frac{1}{2}$ ounce; and charcoal, $\frac{1}{4}$ ounce. The scoria resulting from this fusion will be of a light-blue colour, clouded, and variegated like an agate, and very transparent. The great distance of Elba from this country precludes the possibility of using this ore in our manufactories with any

 profit,

profit, unlefs it could be brought home as ballaft, and delivered in the vicinity of any iron-work at 22s. per ton. The products obtained from it in the affay furnace, indicate, in an uncommon degree, how very valuable the quality of crude iron would be in the fcale of manufacture, by its application.

The Norwegian, Danifh, and Swedifh ores, found in ftrata, refemble, in many points, the Scotch ore of the ifland of Iflay; in affaying them a fimilar treatment is neceffary. Some of them are more fufible, and afford fingular qualities of crude iron. When fufed with oxygenating fluxes, the metal produced is uncommonly hard and brittle; exhibiting a fracture ftudded with brilliant mirrors, diverging the light in fmall radii: even when fluxes are ufed, capable of conveying carbonation, the metal exhibits this bright granulated fracture in a great degree. One of the ores from the mine of Houban, upon being expofed a confiderable time after feparation, afforded a mafs of pretty good fteel. The proportions neceffary to affay thefe, with accuracy, fo intimately depend upon their richnefs, and the relative proportions of mixture with which the iron is combined, that the fame recipe can feldom be applied to more than one variety. As iron-ftones are more defined, and their treatment prefcribed by more certain rule, a knowledge of them will foon lead to a juft comprehenfion of the primary ores; a fecond experiment, therefore, with any of them, will be fufficient to point out the neceffary proportions for obtaining in the next affay carbonated crude iron. In one collection of Norwegian ores I found the following variety :—

No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	
18	21	35	47	55	63	iron
17	16	19	11	24	19	parts volatile
65	63	46	42	21	18	earths
100	100	100	100	100	100	

This

This ſimple table will ſhew plainly how neceſſary it is to accommodate the flux to the variety of the ore. If from this collection you wiſh to obtain carbonated regulus, it is obvious that, in order to ſaturate them equally, the iron contained in No. 3 ought to be preſented with double the quantity of carbon neceſſary to carbonate No. 1; No. 5 with a triple quantity; that of No. 6 with more than $3\frac{1}{2}$: and as I have proved that this effect will be chiefly produced with the uſe of a calcareous earth, it will at once be conceived how far this ſubſtance is to be uſed as the inſtrument of alteration.

In the recipes adduced in this and the preceding paper, I have always noted charcoal as a conſtituent of each mixture. Since I diſcovered that the contact of calcareous earths conveyed carbonation to the metal, by the decompoſition of the carbonic acid, I have reduced the proportion of charcoal commonly uſed in the flux, and have, in the treatment of moſt iron-ſtones, even abandoned it altogether: however, as my experiments have not yet extended univerſally to primary ores, I have, in the mean time, retained it as a conſtituent part of the ſolvent.

XII. *On the Comparative Height of the Mountains of the Earth, the Moon, and Venus* *.

SCHROETER, the learned aſtronomer of Lilienthal, who has ſeveral excellent teleſcopes by Herſchel, publiſhed ſome time ago a work on the height of the lunar mountains, as compared with thoſe of the earth; and lately he has publiſhed a new work on the height of the mountains of Venus. Faujas, who not long ago undertook a journey into Germany, of the utmoſt importance to the ſciences, brought back with him theſe two works of Schroeter. We there ſee the manner in which that indefatigable aſtronomer makes

* From the *Journal de Phyſique, Prairial, An.* 7.

his

his obfervations. It is by the projection of the fhadows formed by thefe mountains when they begin to appear on their horizon in regard to us, or when they are about to difappear below the horizon. He diftinguifhes the mountains into different orders.

The plate in Schroeter's work confifted only of outline, and he expreffed the diameter of the three globes merely by ftraight lines. The annexed delineation (See Plate VIII.) was drawn by Alexander Faujas, the fon, who to military talents unites a ftrong attachment to the fciences. He has rendered the height of the mountains more juft, and, from his drawing, the refpective magnitude of the three globes can be better eftimated. It is here feen that the moon, which is about forty-nine times fmaller than the earth, has mountains more than 4000 toifes in height *; while that of Chimboraco, one of the Andes in South America, the higheft mountain of our globe, is little more than 3000. Venus, which is lefs than the earth by a ninth, has mountains 23,000 toifes in height. It muft here be remarked, that the higheft mountains on thefe three globes appear all to be volcanic.

XIII. *Defcription and Ufe of a new Portable Inftrument for afcertaining the Comparative Strength of Gun-Powder. By* C. REGNIER †.

IN the proceffes employed for the improvement of gunpowder, it is neceffary to make comparative experiments; and various ingenious inventions, which it is unneceffary to defcribe, as they are well known, have been ufed for that

* The French toife is to the Englifh fathom as 1 to 1·0664.

† From *Mémoires explicatifs du Dynameter et autres Machines inventées par C. Regnier*, 4to, Paris, An. VII. The inftruments here defcribed are, 1. The dynamometer, of which a plate and defcription were given in the Philofophical Magazine for September 1798: 2. A fafeguard for the priming in mufkets: 3. The powder-proof above-mentioned; and, 4. An electrical machine.

purpofe.

purpofe. I fhall, therefore, only obferve, that trials of gunpowder on a large fcale are always the beft; but as fuch experiments require certain kinds of apparatus and conveniences which are not always at command, a fmall powder-proof, in the form of a piftol, the blaft of which drives a fmall toothed or turned wheel that rubs againft a fpring, and is moved through a greater or fmaller fpace according to the ftrength of the powder, has been long ago adopted and brought into common ufe. This machine, however, is very defective in regard to the refults which it gives, and can be of no utility when an abfolute or approximate indication is required of the relative ftrength of a given weight of powder intended for fire-arms, which are loaded with quantities determined in this manner: thefe proof-inftruments have indeed an arbitrary graduation, and their friction varies according to the ftrength of the fpring and the cleannefs of the mechanifm.

To obviate thefe inconveniences, I made feveral experiments, which led me to a more valuable and accurate principle; and, with fome variations, I at length fitted a fmall brafs cannon to the fpring of a common weighing inftrument. By this application I was enabled to weigh the effort of the blaft, and confequently obtained a comparative method of afcertaining its action. This inftrument is attended likewife with this valuable advantage, that it acts without friction. Its graduation is accurately determined, becaufe it expreffes the weight which ferved for that purpofe; and it may likewife be applied for weighing fuch bodies as come within the limits of its fcale.

A perfpective view of this inftrument is reprefented, (Plate IX. fig. 1.) BC is a fpring bent fo as to form an angle; D a fmall brafs cannon capable of containing exactly 15' grains of fine gunpowder; E the graduated arc, each divifion of which is nearly equal to 2' pounds averdupoife, and terminating in a fcrew that ferves as a breech pin to the cannon. F is a cap which may be confidered as

the

the body to be projected. It closes the mouth of the small cannon, upon which it presses with a force equal to four kilogrammes. This cap is strongly fastened to one of the spring radii by a nut at the opposite end of its tail. G is a piece of strong brass wire, fixed to a projection, which, by means of a small screw, is riveted into one of the radii. H, an index of woollen cloth or leather, which slides with a gentle friction on the wire, when the branches of the spring are pressed together by the explosion of the powder. This index remains at the place to which it has been pushed, and shews exactly how far the springs have been made to approach. When the instrument is to be used, the two extremities of the spring are to be pressed together, to separate the cap from the mouth of the cannon, into which powder is poured, till it is exactly full, by means of a card or a piece of paper. The stopper is then suffered to approach the muzzle gently, so as to close it exactly, without leaving a single grain of powder between them. The circular piece of cloth or leather, which supplies the place of an index, is to be brought into contact with that branch of the spring to which the tail of the stopper is fixed; and priming being put into the small pan of the cannon, it is discharged, the instrument being held suspended by a string or ribbon. The effects of the explosion are, that, as the powder occupies a greater space by its inflammation, it drives back the stopper, and the latter carries with it that branch of the spring in which its tail is fastened. This branch cannot move, in regard to the other, which is made to move also by the recoil of the gun, without driving before it the small index piece; and the space over which the index piece is carried will shew the force of the powder.

The arches moved over by the explosion of the different kinds of powder will shew, by the number of degrees, the comparative strength of each. A star is marked on that arch which shews the strength of powder of a mean quality; so that the relative value of any sample, in regard to that medium,

medium, may be known. The friction of the index is the only friction to which the inſtrument is ſubject; but it is ſo ſmall that it may be conſidered as of no conſequence. When the index is worn out, its place may be eaſily ſupplied by a new one. It may be readily comprehended that, by adding a hook to the perforation at the extremity of the divided arc, and a ring in the eye of the ſtopper, the inſtrument may be employed for weighing.

XIV. *Account of a Red Subſtance obſerved on the Surface of a Fiſh-Pond in Norway. By Profeſſor* H. Ström *.

In the ſpring of the year 1790, a pellicle, or ſubſtance of a red colour, was obſerved on the water at one end of a fiſh-pond in Norway, which ſoon after began to ſpread till it covered the whole ſurface. During dry and warm weather, the red colour was more perceptible than when it was cold and wet. It was more viſible alſo at noon, than in the morning and evening. I, however, did not pay much attention to it until the colour, about the end of June and the beginning of July, became ſtronger than it had ever been before; it was ſtrongeſt at noon, and always proceeded, in regular order, from the end of the pond till it gradually extended over the whole ſurface. I filled a beer glaſs with the water, which had a red appearance in the glaſs; but the red matter ſoon depoſited itſelf at the bottom, and the water became yellowiſh: for a long time, however, it had a frothy pellicle, which was ſometimes of a red and ſometimes of a green colour. I let fall a drop of this pellicle on my microſcope, and beheld the ſingular phenomenon exhibited in the annexed engraving, (Plate IX. fig. 2.) which repreſents this drop as ſeen when magnified.

* From *Tranſactions of the Society of Natural Hiſtory at Copenhagen*, Vol. I. Part 2.

I beheld partly large and partly ſmall bubbles, reſembling bright ſpecula, ſurrounded by a dark rim or margin, which were ſometimes like ſmall rings (1,1), and ſometimes broader; ſo that the bright ſpeculum in the middle formed the ſmaller part (2,2). Every where around were ſeen an immenſe number of minute globules of the ſize as repreſented in the figure; conſequently aſtoniſhingly ſmall in regard to the ſpecula, but ſimilar to them in this reſpect, that they had a bright point like a ſpeculum in the middle. At firſt, as far as I could obſerve, they were black, or of a dark colour, the bright point excepted; but the red colour afterwards ſhewed itſelf very clearly. In thoſe that were red, the bright point was always ſeen; but this was not always the caſe with the dark ones. All theſe round bodies or globules appeared at firſt, though very ſeldom, to have ſome life and motion, but afterwards they entirely loſt all movement; and this was the caſe in particular with the red, which ſeemed entirely lifeleſs. I could alſo clearly obſerve, that the red matter, which depoſited itſelf in abundance at the bottom of the veſſel, was nothing elſe than an aſſemblage of ſuch round globules which had loſt all life and movement. Beſides theſe round globules with a bright point in the middle, I ſaw in the pellicle on the water, as well as in the water itſelf, another kind of living animals in greater numbers (3), which were ſhaped like ſmall fiſh, and perfectly ſimilar to the *Cercariæ virides* of *Müller* *, which produce the green covering on ſtagnant water; but with this difference, that they were no larger than they are repreſented in the figure, and that they had not a green but a dark appearance. I obſerved alſo, though with difficulty, that the tail was forked; and that ſome of them, cloſe to the tail, had a bright point or reflection, while the body before was not brighter than that of the *Cercaria viridis*. Theſe ſmall animals moved with great alertneſs and vivacity in the

* See his *Animalcula infuſoria*, No. 130, p. 126.

drops

drops of water; but they collected themselves sometimes together (5 and 6), and tumbled several times round in a circle (4). I observed also, that, when they began to lose life and animation, their longish figure was changed, and they assumed that of a triangle or funnel, with a tail or tube (5). Müller observed the same thing in the *Cercaria viridis* *, and at last they acquired the form of a globule, which is represented also in Müller †. I have no doubt that these globules were the same round animals, though dead, of which I have already spoken; especially as Müller says of his *Cercariæ virides*, that they can assume a globular form. Of the bright points in the middle he says nothing; and it appears singular to me that he did not observe them, as he viewed them much more magnified than I did. He says as little of the red colour which they can assume and communicate to the surface of the water, and nothing at all of the bright bodies or small specula inclosed in round rims, which were perfectly like the small round globules with a bright point in the middle, only that they were some hundred times larger. But I dare not affirm that they were of the same kind, and only different in size. It is very probable that they consisted of the slime of the dead *Cercariæ*, which formed bubbles by means of the air inclosed in them; for, that they were round like bubbles, appears from this circumstance, that they eluded every impression, and sometimes divided themselves into two or more smaller bubbles, and even by a stronger impression extended to a longish, oval, and irregular form like those marked (6), which shews that they consisted of a tough slimy substance. Among some small animals of another kind, seen sometimes in the drops of water, none were more conspicuous than the *Brachionus urceolaris* ‡, by its transparency, and the three or four round balls, or *ovaria*, which it has at the hind part of

* *Animalcula infusoria*, Tab. 19. fig. 9.

† Fig. 7 and 13.

‡ Müller's *Animalcula infusoria*, No. 377, Tab. 50. fig. 15-21.

its

its body. But what diſtinguiſhed it moſt was, that, with the briſtles or hair at the fore part, it often put the water in a ſort of vortical motion, which made the ſmall lifeleſs globular animals move quickly round in a circle, as if they had been alive (7). Such was the nature of this ſubſtance for a few days in July, till it increaſed more and more; and I found, when I filled a glaſs with it, a covering on the ſurface, of the thickneſs of the finger, beſides the matter depoſited at the bottom; but no living beings were now obſerved in it, and not many of the dead globular animals: they ſeemed all to be converted into the above red ſlimy matter, the colour of which was perfectly ſimilar to that of the bright yellow ochre uſed for painting houſes.

What I have above ſaid will ſufficiently ſhew that the red colour of water, which has ſo often been a matter of terror to the ſuperſtitious, may ariſe from the innocent infuſion animals; and that animalculæ, like thoſe which I ſaw in freſh or ſtagnant water, may be found in ſalt water or the ſea, will be doubted by no one who knows that the latter has its infuſion animals alſo. We often read in books of voyages, that the ſea has ſometimes had the appearance of blood, ſometimes of ſnow or milk; and that it has even ſometimes had an appearance as if on fire. All theſe phenomena can be aſcribed to nothing elſe than the foreign matters, and particularly ſmall animals, which multiply there in immenſe quantities, and are ſometimes red, ſometimes white, and ſometimes of a flame colour, like Müller's *Trichoda ignita* *, without including the *Nereis noctiluca*, and ſeveral others. It ſeems to me highly probable that, in regard to colour, they may be ſubject to different variations; as is the caſe here, from black to red, and even from red to green; as appears from this circumſtance, that the red ſkin or pellicle, after ſtanding a few days in the glaſs, was in ſome parts green. It is alſo probable that ſuch ſmall animals may ariſe from

* *Anim. infuſoria*, No. 203, p. 186.

the

the ſo called *Grönſke*, which in ſpring is ſeen in the Norwegian ſeas; eſpecially as it riſes or falls according to the heat or cold. The uncommon colour in water, which I have here deſcribed, is a remarkable phenomenon; and, during the eleven years I reſided in the neighbourhood, I never ſaw or heard of any change of the like kind in other fiſh-ponds. I therefore paid more attention to it, and eſpecially as in former times ſuch appearances were conſidered as portending wars and bloodſhed: but theſe ſuperſtitious notions muſt loſe all credit when the above explanation is adopted, and when the ſecrets of nature are more accurately explored. In regard to the cauſe of this phenomenon I muſt confeſs that to me it is inexplicable; and that it is eaſier to ſay what it is not, than what it is. It is well known that the quality of the atmoſphere, ſome years, can produce worms and inſects in incredible numbers: but what kind of weather is neceſſary for the generation of theſe infuſion animals, and whether a continual alternation of rain and ſun-ſhine, which was the caſe in the ſummer above mentioned, contributes to the phenomenon, is difficult to be determined.

P. S. The red matter continued on the water during the whole month of Auguſt, and ſeemed ſtill thicker; but the red particles were ſmaller, and ſeemed entirely deſtitute of life. The corrupted and green water below ſwarmed, on the other hand, with the *cercariæ* already mentioned; which ſometimes appeared of a triangular and ſometimes of a circular form, as already ſaid. Some green ſlime was obſerved alſo in the red matter; which however did not proceed from the latter by a change of its colour from red to green, as I at firſt ſuppoſed, but was either a ſlimy ſubſtance ariſing from the decompoſed green *cercariæ*, or ſome other corrupted ſlime, which partly kept itſelf ſeparate from the red matter, and partly mixed itſelf with it and diſappeared. At any rate, I found in it no red, but here and there a ſhrunk and wrinkled *cercaria*: but it muſt be obſerved, that what I

have, in ſeveral places, called black, may have been that dark green or almoſt black colour which M. Müller gives to his *Cercaria viridis*, and which, no doubt, would have ſhewn itſelf under a microſcope of a ſtronger magnifying power, if I had been in poſſeſſion of one at the time.

XV. *Obſervations on the ſingular Sagacity of the Rock or Ice Fox* *.

DURING my abode, ſays Steller, on Behring's iſland, I had opportunities, more than enough, of ſtudying the nature of this animal, far excelling the common fox in impudence, cunning, and roguery. The narrative of the innumerable tricks they played us, might eaſily vie with Albertus Julius's hiſtory of the apes in the iſland of Saxenburg. They forced themſelves into our habitations by night as well as by day, ſtealing all they could carry off, even things that were of no uſe to them; as knives, ſticks, clothes, &c. They were ſo inconceivably ingenious as to roll down our caſks of proviſions ſeveral poods in weight, and then ſteal the meat out of them ſo ably, that at firſt we could not bring ourſelves to aſcribe the theft to them. As we were ſtripping an animal of its ſkin, it often happened that we could not avoid ſtabbing two or three foxes, from their rapacity in tearing the fleſh out of our hands. If we buried it ever ſo carefully, and added ſtones to the weight of earth that was upon it, they not only found it out, but ſhoved away the ſtones, as men would have done, with their ſhoulders plying under them, helping one another with all their might. If, thinking to ſecure it, we put any on the top of a high poſt in the air, they grubbed up the earth at the bottom, ſo that the poſt and all came tumbling down, or one of them clambered up and threw down what was upon it with incredible artifice and dexterity. They watched all our motions, and

* From *Tooke's View of the Ruſſian Empire.*

accom-

accompanied us in whatever we were about to do. If the ſea threw up an animal of any kind, they devoured it ere a man of us could come up, to our great diſadvantage; and if they could not conſume it all at once, they trailed it away in portions to the mountains, where they buried it under ſtones before our eyes; running to and fro as long as any thing remained to be conveyed away. While this was doing, others ſtood on the guard, and watched us. If they ſaw any one coming at a diſtance, the whole troop combined at once and began digging all together in the ſand, till they had ſo fairly put a beaver or a ſea-bear under the ſurface that not a trace of it was to be ſeen. In the night-time, when we ſlept in the field, they came and pulled off our night-caps, and ſtole our gloves from under our heads, with the beaver-coverings, &c. In conſequence of which we always ſlept with clubs in our hands, that, if they ſhould wake us, we might drive them away, or knock them down.

When we made a halt to reſt by the way, they gathered around us and played a thouſand tricks in our view; and when we ſat ſtill, they approached us ſo near that they gnawed the thongs of our ſhoes. If we lay down, as if intending to ſleep, they came and ſmelled our noſes to try whether we were dead or alive; if we held our breath, they gave ſuch a tug to the noſe as if they would bite it off. On our firſt arrival they bit off the noſes, fingers, and toes of our dead while we were preparing the grave; and thronged in ſuch manner about the infirm and ſick, that it was with difficulty we could keep them off. Every morning we ſaw theſe audacious animals patrolling about among ſea-lions and ſea-bears lying on the ſtrand, ſmelling at ſuch as were aſleep to diſcover whether ſome of them might not be dead; if that happened to be the caſe, they proceeded to diſſect him immediately, and preſently after all were at work in dragging the parts away. Becauſe the ſea-lions at night, in their ſleep, frequently overlay their young, they examine, as if conſcious of that circumſtance, every morning, the whole

herd of them one by one, and immediately drag away the dead cubs from their dams.

Seeing, now, that they would not fuffer us to be at reft night or day, we were in fact fo exafperated at them that we killed them young and old, and plagued them by every means we could devife. When the party awoke in the morning, there always lay two or three at our feet, that had been knocked on the head by fome of us in the night; and I can fafely affirm, that, during my ftay on the ifland, I flew above two hundred of them myfelf. The third day after my arrival, I knocked down, within the fpace of three hours, upwards of feventy of them with a club. They were fo ravenous that, with one hand, if we held to them a piece of flefh, they would come to it, although we might have a ftick or ax in the other to knock them on the head.

When thefe bufy animals could not get hold of what they wanted, as the clothes we put off, &c. one of them would void his excrement upon it, and all the others which paffed would do the fame. From all circumftances it was clear to us, that they had had very little communication with human beings, and that the dread of man is not innate in brutes, but muft be grounded on long experience.

In October and November they, like the other foxes, were the moft fleek and full of hair: in January and February the growth of it is too thick: in April and May they begin to fhed their coats: in June and July they had only wool on them, and looked as if they went in waiftcoats. In June they drop their cubs, nine or ten in a brood, in holes and cliffs of the rocks. They are fo fond of their young, that, to fcare us away, they would bark and yelp like dogs, and thereby betrayed their coverts. This mode of preferving their young, probably, has procured them the name of ice or rock foxes. No fooner do they perceive that their retreat is difcovered, than, unlefs difturbed, they drag away the young in their mouths, and hide them in a more fecret place. On killing the young, the dam follows the flayer with grievous howl-

ings,

ings, day and night, for a hundred and more verfts, and never ceafes until fhe has played her enemy fome trick, or is killed by him.

They ftink much more horribly than even the red foxes. In rutting time they run together day and night, the males biting each other, from jealoufy, like dogs. When they couple, they fcream like the cats. In ftorms and heavy falls of fnow, they bury themfelves in the fnow, and lie ftill as long as it lafts. They fwim acrofs rivers with great agility; will feize the fea-fowl by night on the cliffs when they have fettled to fleep; but are themfelves frequently victims to the birds of prey. Thefe animals, which are now in fuch inexpreffible numbers on the ifland, were moft probably conveyed there (fince there is no other land animal in it) from the Continent on the drift ice, and have been nourifhed by the great quantity of animal fubftances thrown up by the fea.

This fpecies is entirely white, and their furs compofe a confiderable article of commerce.

XVI. *An Account of Mr.* BROWN'*s Travels through Egypt and Syria*, &c.

[Continued from Page 247.]

ON the 28th of December 1792, Mr. Brown left Kahira to vifit Feiûm, a city diftant about fixty miles to the fouthweft. It ftands on the principal canal leading from the Nile to the lake Mœris, and is furrounded with cultivated ground producing that profufion of rofes for which this place was celebrated, and which were diftilled into rofe-water. The mode of propagating them was by continued layers; the young twigs thence arifing being found to produce the largeft and moft fragrant flowers. The rofe-water was excellent, and fent to all quarters; but the cultivation is now running gradually to decay: wheat and other grain abound in the vicinity.

After paſſing three days at Feiûm Mr. Brown proceeded towards the lake, of which he wiſhed to make the circuit. It is the Mœris of Strabo and Ptolemy; and the teſtimony of the latter living in Egypt ſeems unqueſtionable. However this may be, the lake now called *Birket-el-kerun*, probably from its extremities bearing ſome reſemblance to horns, ſhews no mark, as ſome ſuppoſe, of being the production of human art. The length, Mr. Brown ſays, may probably be between thirty and forty miles; the breadth, at the wideſt part he could gain, was 5000 toiſes, as taken with a ſextant; that is, nearly ſix miles. The utmoſt poſſible extent of the circuit muſt of courſe be thirty leagues. Several fiſhermen, in miſerable boats, are conſtantly employed on the lake. The water is brackiſh, like moſt bodies of water under the ſame circumſtances.

From Feiûm Mr. Brown travelled ſouth-eaſt, and at Hawâra ſaw two ſmall pyramids of unburnt brick. Returning to Bedis he paſſed, the day following, the pyramids of Daſhûr; five of which appear ſucceſſively, beſides thoſe of Sakarra. The third, after thoſe of Hawâra, is that of Medun, which has been very elegant. It is compoſed of large pieces of the uſual ſoft free-ſtone, joined together with a little cement, and has been hewn off to a ſtraight ſurface. It would be extremely difficult to aſcend to the top, which is now very broad; but it is probable that there was another ſquare completing its ſummit, which has been removed. The fourth is the moſt ſoutherly of the four pyramids of Daſhûr, where there are two large and two ſmall. It is in the form of a cone terminating in an obtuſe triangle, and is now much damaged. At Sakarra a great number exiſt, among which ten are of a large ſize *.

* Speaking of the pyramids of Jizé, well known to all who have viſited Egypt, Mr. Brown ſays: "An abſurd opinion has recently been ſtated, that the pyramids are hewn out of the rock on which they ſtand; but the firſt ocular inſpection would ſet aſide this, the joinings of the ſtones being every-where marked with cement." This is a flat contradiction of what has been aſſerted by Bruce.

On

On the 1ſt of March 1793 Mr. Brown left Kahira to proceed to Suez, which he reached after a tedious progreſs of five days. The town is ſmall, and built of unburned brick. It contains twelve moſques, ſome of which are of ſtone, but the moſt are mean buildings. The ſea near the town is very ſhallow, yet there is a ſmall yard for ſhip-building. The Arab mode of conſtructing ſhips is ſingular. They have no art to bend the timbers; none of them are crooked, except naturally ſo. They are very ſlender; and, where the upper and lower ribs join, do not paſs over one another, but by the ſide of each other. The ſea here produces few fiſh. Oyſters, indeed, and ſome others of the ſhell-kind, are ſeen: the beſt fiſh do not come higher than Coſsîr. Meat is ſcarce; bread of an inferior quality, and ſometimes hardly eatable. Butter and milk are brought in ſmall quantities by the Arabs. Water is brought from three ſeveral places. It is always bought by the ſkin, at a conſiderable price; and if a war were to ariſe with the Arabs, none could be found.

On the 8th of March 1793 Mr. Brown paſſed the ford at Suez, and on the 14th arrived at Tûr. On the 18th he left Túr, and on the 22d, at half paſt three in the morning, reached the Monaſtery of Sinai. The convent is large, with a good garden, to which there is a ſubterranean paſſage. Within the walls is a ſmall moſque for the convenience of the Arabs. The mountain now called Sinai is high and abrupt: on the north ſide of it ſome ſnow was viſible. The whole is a very remarkable rock of red granite, interſperſed with ſpots to which ſoil has been brought by human labour, or waſhed down by rain, and in which grow almond-trees, figs, and vines. Numerous rills of excellent water guſh from various apertures in the precipice, and wander among the little gardens. Sinai has two ſummits: the higheſt, it is believed, may be the Sinai of Moſes. The weather being very clear, Mr. Brown obſerved from Mount Sinai the Eaſtern Gulph of the Red Sea, which appears very

 ſmall,

ſmall, and more round and ſhort than is laid down in the lateſt maps. Mr. Brown returned to Suez and Kahira, without meeting any thing remarkable on the road.

Mr. Brown's views to the ſouth of Egypt having been fruſtrated the preceding year, he was reduced to the alternative of abandoning any further projects in that quarter, or of waiting for a more ſeaſonable opportunity. This ſoon occurred. He had formed a deſign of penetrating to Abyſſinia by the way of Dar-Fûr, as he was taught to believe that he might hope there for the advantages of a regular government, and, with proper management, might expect every favour from the monarch. At the moment of his return from Aſsûan to Aſſiût, the caravan of Jelabs from Dar-Fûr, called *Cafflet-es-Soudân* *, the Soudân caravan, arrived at El-wah. It was then reported, that the ſale of their merchandize and ſlaves, of which they had no great quantity, would be completed in about two months, and that then they would return home. Their ſtay, however, was protracted during the whole winter, and in the month of March 1793 they commenced their departure from Kahira for the Upper Egypt. They were ſlow in collecting ſuch things as were neceſſary, and Mr. Brown made uſe of the time ſo allowed to procure information from various quarters reſpecting the journey.

On the 21ſt of April 1793 he ſet out from Bulak, and on the eighth day, the wind having been often unfavourable, reached Aſſiût. The firſt care was to provide camels for the route; but, unfortunately they were at that time ſcarce. He, however, at length obtained five at about 13l. each. A ſupply of food was alſo procured for the journey; and the caravan having aſſembled, after about fifty days, the expected moment of departure arrived. The party having left Aſſiût on the 25th of May, encamped on the mountain above it till the 28th. On the 31ſt they arrived at

* Soudân, in Arabic, correſponds to our Nigritia, merely general words for the country of the Blacks.

Gebel

Gebel Rumlie, a high rocky mountain which they were to defcend. It forms the weftern fide of the ridge, which conftitutes, as it were, the wall of Egypt, and the eaftern boundary of the low defart in which lie the *Oafes*. It confifts of a coarfe *tufa*, and is of rugged and difficult defcent. They were employed four hours and a half the following morning in paffing from the foot of the mountain to Ainé Dizé, the firft place where water is found, and the northern extremity of the great *Oafis*. As a hot wind blew here during the meridian hours, the thermometer ftood at that time, under the fhade of the tent, at 116 degrees. In marching from Ainé Dizé to Charjé, eight hours were employed. They left Charjé on the 7th of June, and on Monday the 10th arrived at Beiris. On the 13th they proceeded to Mughefs, the laft village of the Oafis towards the fouthern defart; which they left on the 15th, and on the 20th reached Seb. This place is marked by the production of a quantity of native alum, as the name imports. The furface near which the alum is found abounds with a reddifh ftone, and in many places is feen argillaceous earth.

Having left Seb on the 21ft, they arrived at Selime on the 23d. On the 24th they refted, and, continuing their route next morning, employed five days more in reaching Leghea. While they remained here, they felt much inconvenience from a fuffocating wind, which blew from the fouth, and raifed the fand in clouds. On the 2d of July the caravan left Leghea, and on the 8th, after a fevere and fatiguing march, reached the *Bir-el-Malha*, or falt fpring. The vicinity of this fpring is remarkable for the production of *natron*, which appears under various circumftances, and is of a quality different from that of Terané. It is very white and folid, and, on immerfion in water, becomes hot, and difcharges a great portion of its air. Small quantities of it are carried by the jelabs to Egypt, where it is fold at a high price, and is ufed principally for making fnuff. The water found here is unpalatable and brackifh.

They

They remained at Bir-el-Malha till the 12th, and on the 20th encamped at a ſpot called Medwa. On the 23d they came to the firſt ſprings within the limits of Fûr, which are in this place called Wadi Maſrûk. The white ant, *termis*, was here exceedingly vexatious, building its covered way to every thing within the tent, and deſtroying all within its reach. This, together with the rains, which were now increaſing, and began to pour in a torrent through the valley, obliged them to abandon their tents, and to take ſhelter in the next village (Sweini), where Mr. Brown obtained an apartment in the houſe of Ali-el-Chatib, one of the principal merchants eſtabliſhed in the country. There he ſpent eight or ten days, and did not arrive at Cobbé, one of the towns to which the jelabs chiefly reſort, till the 7th of Auguſt. A Melek, or governor, on the part of the Sultan of Dar-Fûr, generally reſides at Sweini; and there all ſtrangers, as well as merchants of the country, coming with the caravan, are obliged to wait till the pleaſure of the monarch in diſpoſing of them be known.

As Mr. Brown had come to the country under conſiderable exceptions from the general rule of merchants trading to this country, and, in the Arabic language, rather as *Daif-es-Sultan*, the king's ſtranger, in which light he had been hitherto viewed by the natives, he expected to obtain immediate permiſſion to continue his journey to the royal reſidence. "I obſerved," ſays he to the Melek of Sweini and other public officers, "that, intending to viſit the Sultan, I ſhould hardly have expected to be put back with frivolous excuſes, as the non-payment of duties which you dare not explicitly demand of me, and tributes, under the name of preſents, which have never yet been exacted of any ſtranger. If any duties be payable, beyond what have been already diſcharged, you are perfectly at liberty to detain all, or ſuch part of the articles I bring with me, as you may judge ſufficient to anſwer your claim, but not to refuſe me permiſſion to go to the Sultan, with whom I have buſineſs.

Or,

Or, if other reafons operate to prevent my requeft from being complied with, and if any fufpicions prevail relative to my views in coming here, I defire, without further delay, to be furnifhed with the means of returning to Egypt, before I fuffer, as commonly happens to ftrangers, from the effects of the climate, while I am yet in the habit of travelling, and while the funds are yet unexhaufted which fhould fupport me in my progrefs farther."

The mifreprefentations which had been made concerning Mr. Brown, and which had by this time reached the Sultan, manacled the hands of the Melek, and prevented his remonftrance from having any effect. Finding, therefore, no mode of advancing till the reft of the caravan fhould obtain the fame permiffion, he refolved to follow the example of the other jelabs, and wait patiently the event. At length, after the expiration of about ten days, an order from the Sultan arrived, directing that all the jelabs fhould be allowed to proceed to their houfes on paying the duties affeffed on them.

Before leaving Kahira, Mr. Brown had been apprifed that all commerce in Dar-Fùr was conducted by means of fimple exchange. To carry on this, in fuch a way as not to be grofsly defrauded, he was induced to feek for a perfon who might go through this bufinefs for him, at leaft with fome fhare of probity. The perfon recommended to him for that purpofe had been a flave-broker in the market of Kahira; and though Mr. Brown expected from him that fubmiffion and obedience for which the lower claffes of the Kahirines are, externally at leaft, remarkable, he was difappointed in his expectations. The letters with which he was provided for different merchants in this diftrict, under whofe roof he might have had a fafe lodging, could be of no ufe till he had feen the Sultan; for, till then, no perfon knew in what character to receive him. The object of this man, therefore, was to prevent his introduction to the Sultan, and to preclude him from any opportunity of reprefenting his

cafe.

case. They were no sooner arrived at Sweini than he found means to employ one of his associates, who had been some years established in the place, to go to the monarch and infuse into his mind suspicions of him as a Frank and an Infidel, who came to the country for no good purpose, and whose designs it behoved him to guard against. The villain himself was in the mean time not idle. As the house in which Mr. Brown lodged had no doors, he took advantage of this circumstance, and his momentary absence, to secrete from a box, which he had broken on the road, a quantity of red coral. By the help of this commodity, Mr. Brown had expected to make his way to the Great. At the end of a few days, this agent returned, bearing a specious letter impressed with the Sultan's seal, ordering that no officer on the road should presume to detain him, or take any thing from him, till he came to the house of *Ibrahim-el-Wohaishi* (the name of this very agent) in Cobbé, where he was to rest himself till further orders. In this situation, seeing no means of immediate relief, Mr. Brown began to feel impatience, which, as he continued in a state of inactivity, communicated the more rapidly its pernicious influence to his health. On the fourteenth day he was attacked by a fever, attended with extreme pain in the head. How long it lasted he could not tell, having lost his recollection on the second day. It was afterwards recalled by the effect of a dysentery, which lasted for two days, and left him too weak to assist himself.

A little more than a month elapsed, when, the symptoms appearing to diminish, he again pressed to be permitted to visit the residence of the Sultan. But he had reason to regret his impatience; for, having at length obtained leave, he proceeded to El Fasher only to repeat his sufferings. When he arrived at El Fasher, he was first introduced to the Melek *Misellim*, one of the principal ministers. He received him with a rude stare, as an object he was unused to, which was followed by a smile of contempt and aversion.

He

He was feated, with fome more of the royal attendants, under a kind of awning of cotton cloth, on a mat fpread upon the fand. After the common falutations, the Melek and his company entered into converfation on the nature of his vifit to the country; while each made remarks on his perfon, and offered conjectures as to his character and intentions. At length a wooden bowl of *polenta*, and another of dried meat, were fet before them. Mr. Brown's illnefs deprived him of all inclination to eat, and, obferving the company not much inclined to invite him to join them, and yet embarraffed to avoid that ceremony, he relieved them by declining it, and defiring them to begin. When they were fatiated, a great number of foolifh queftions were afked him about Europe; fome of which he waved, and fatisfied them as to others in the beft manner he could. When he obferved that they grew tired of afking queftions, he feized the opportunity of explaining why he came there, and what favour he expected would be fhewn to him. "Melek," faid Mr. Brown, "having come from a far diftant country to Mifr (Kahira), I was there made acquainted with the magnificence, the extended empire, and, above all, the juftice and hofpitality of the king Abd-el-rachmân. Having been ufed to wander over various countries as a *derwifh*, I grew defirous of feeing Dar-Fûr. I was told that my perfon and property would be fecure: but fince my arrival within the confines, I have found all thefe affurances fallacious; my inclinations have been thwarted, my perfon treated with indignity, and my property plundered. I afk redrefs—I defire the punifhment of the man who has robbed me, and reftitution of what has been taken. Nor is this all; I particularly defire permiffion to go to Sennaar, in order to proceed to Habefh. I was prevented from going there laft year by the ftraight road. Habefh is a Chriftian country, abounding in flaves and gold: there are alfo many herbs valuable in medicine. Being there, I may eafily join my countrymen, merchants who come to Moccha,

Moccha, in the Bhar Yemeni. I desire the Sultan will allow me to proceed thither; and, if it be necessary, grant me his protection, and three or four persons, deserving confidence, to attend me to the frontiers of Kordofân. I have a small present to offer him, consisting of such things as my circumstances permitted me to bring. I hope he may not refuse to receive it, and to grant me the favour I ask."—He answered: "Merchant, you are welcome to the *Dar*. The king is kind to strangers, and he will favour you in all you wish. Whatever you want, you have only to demand. He has ordered a sack of wheat and four sheep to be sent you. At this time it is not possible to pass through Kordofân: the Sultan has a great army there; and when the country shall be in subjection to him, you may pass unmolested. When you are admitted to his presence, you will tell him who has robbed you, and what you have lost; and he will cause it to be restored." It was now the hour of prayer, and, when the company commenced their ablutions, Mr. Brown retired.

[To be continued.]

XVII. *On the Disappearance of Swallows in Autumn; in a Letter from Mr.* Peter Cole *to Dr.* Mitchill, *dated New-York, September* 25, 1798 *.

In consequence of the epidemic now raging in this devoted city, I have not had an opportunity to give you a detail of what I intimated to you some time ago relative to the disappearance of swallows.

In my early years, a number of my school-companions and myself used to make it a practice to hunt what we termed Ground-Swallows (*hirundo riparia*), in a bank in the neighbourhood of this city, contiguous to where the Jews burial-ground then was. In one of these boyish amusements I recollect two gentlemen passed nearly by us,

* From the *American Medical Repository.*

 who

who ftopped and examined the birds we had dug out of the hill; whereupon a converfation took place relative to the migration of the fwallows. The gentlemen both agreed that they were preparing for their winter quarters; and one of them farther added, that he fuppofed that numbers of them kept in a meadow clofe by. Thefe obfervations made fuch ftrong impreffions on my mind, that they have never fince been erafed.

After our revolutionary war was over, and my return again into this city in 1783, in order to be convinced of the truth on this curious and controverted fubject, I made it a practice to walk around the Collect *, mornings and evenings, in the feafons when they affembled, in order to mark their flight or return again; but could not difcern any thing material until the 3d inftant. As I was ftanding at my door between the hours of five and fix in the morning, I obferved a very large flock of fwallows flying in an cafterly direction. I immediately repaired to the pond, where there was already a vaft number collected in the reeds and rufhes. They continued coming for nearly the fpace of half an hour, and vaft numbers of them were flying over the water in almoft every direction. Some of thefe birds appeared to run on the furface of the water with great rapidity towards the eaft corner of the pond, and, in the twinkling of an eye, difappeared under the water and rofe no more.

They feemed to crowd principally towards that particular fpot. But what is fomewhat remarkable, and deferves particular notice, is, that among them I obferved a number of white ones intermixed with the reft. While I was ftanding on the edge of the pond with my fpy-glafs, Mr. Brooks, a particular acquaintance of mine, who lives near the place, came towards me. I mentioned my errand to him. He ftood with me a confiderable time, and faw the fame. I obferved to him that there were white ones among them.

* A pond of frefh water adjoining a marfh in the vicinity of the city of New-York.

He

He replied, that they were ſeen three or four days ago. His word may be relied on as a man of ſtrict honour and integrity.

Thus, Sir, I have given you a ſhort ſketch of what has come within my own knowledge, and what I earneſtly wiſhed to diſcover. I hope I ſhall not intrude upon your patience if I ſubjoin an extract from the Chriſtian's, Scholar's, and Farmer's Magazine *. It runs thus:

" *February* 23, 1790. In Ulſter county, in the ſtate of New-York, on an iſland in the Never-Sink-Creek, nearly in the latitude of 41° 30′ north, a Mr. Baker, in the beginning of the month of March laſt, having cut down a large hollow beech-tree, to his ſurpriſe found the cavity in the tree nearly filled with the common barn-ſwallows (*hirundo ruſtica*) of this country, in quantity (by his eſtimation) nearly two barrels: they were in a torpid ſtate; but carrying ſome of thoſe which were not injured by the fall of the tree near a fire, they were preſently re-animated by the warmth, and took the wing with their uſual agility."—This may be depended on as a fact.

I take the liberty alſo to mention another relation from the American Muſeum †. It is taken from Mr. Joſiah Blakeley's letter to Mr. Carey, dated Baltimore, January 7, 1788. As the piece is of conſiderable length, I ſhall only quote a few paſſages from it. He begins thus:

" The hiſtory of our common ſwallows has long been a problem in ornithology. Whilſt people in general ſuppoſed them birds of paſſage, a few, who appear to be better informed, ſupported the contrary. The opinion of the many was founded on what they thought probable; that of the few on facts. In the year 1780 I was converſing with a perſon, who lived about twenty miles from Boſton, on the phenomenon of the ſudden exit but gradual and irregular return of ſwallows. The gentleman to whom I made theſe

* Volume the Second, page 735.

† Volume the Third, page 451-2.

remarks,

remarks, replied, that they were not birds of paſſage; and the cauſe of their ſudden diſappearance, but irregular return, was, they had a fixed day for immerging in the water, but none for emerging from it. On my doubting his hypotheſis, he told me, that as a neighbour of his, not long before, was draining a pond, on a warm day, near the ſeaſon of the year in which the ſwallows firſt appear, his attention was attracted by obſerving the mud, which, in conſequence of draining the pond, had for ſome time been expoſed to the ſun, move and appear animated; he then ordered a quantity of this mud to be conveyed into a room in his houſe, which he cauſed to be gradually warmed by a ſlow fire. From this mud there ſoon aroſe a number of ſwallows, hovering over himſelf and family, who had been ſpectators of their reſurrection.

Theſe few obſervations, however imperfect, may poſſibly afford a large field for ſpeculation to the philoſophic mind, and lead to uſeful diſcoveries. For my own part, I am now become a proſelyte to the doctrine of the ſwallow's remaining in a torpid ſtate during the winter, not only from ſpeculative reſearches, but from ocular demonſtration *.

XVIII. *Meteorological Obſervations made at Padua in the Month of June* 1783, *with a Diſſertation on the extraordinary Fog which prevailed about that Time. By* M. Toaldo †.

Barometer.—Its greateſt elevation was on the 24th and 25th of the month, *viz.* 28 inches 4 lines; its greateſt depreſſion on the 16th, 27 inches 4 lines. In the ſummer months there is generally very little variation in the barometer,

* Pennant, in his Britiſh Zoology, Vol. I. p. 414, feels diſpoſed to ſmile at the accounts given by Olaus Magnus, Derham, and Klein, of the ſubmerſion of ſwallows. Let the phyſiologiſt and anatomiſt reaſon on the matter as they may, there ſeems to be poſitive evidence of the fact. *E.*

† From the *Journal de Phyſique.*

meter, and it remains almoſt always ſtationary. It appears that it roſe very much after the fog, of which I ſhall ſoon ſpeak.

Thermometer.—The month, in general, was cool: its mean heat, which commonly is 19 or 20 degrees, was this year only $16\frac{1}{2}$; for in the latter part of the month the thermometer did not riſe above 22·6, and in the beginning it was at 10. I ſhall obſerve that it fell four degrees between the 16th and 17th, owing to a ſtorm which came on.

Hygrometer.—Notwithſtanding the rain, it always pointed to dryneſs; which proves the exaltation of the vapours.

Rain.—If we conſider the days when it rained little or a great deal, we ought to ſay that the month was extremely rainy, for it rained twenty-two days: but the rain in general was not abundant, as there fell two inches leſs of water than uſual. This obſervation is applicable only to the level country; for in the mountains the rain was exceſſive, and occaſioned a very great ſwell in the rivers and torrents.

But there occurred two particular phenomena to be obſerved, *viz.* the fog and thunder. On the morning of the 18th, after a ſtorm, which had been preceded by ſeveral others, the ſun appeared extremely pale through a light fog, which filled the whole atmoſphere. This fog became ſtill more condenſed the following days; and was not diſſipated by the winds, nor even by the ſtorm of the 26th in the morning, accompanied by a great deal of thunder, which was heard all along the direction of the mountains from one ſea to the other. This fog ſtill exiſted in the beginning of July, and ſeemed to become thicker, at leaſt at certain hours. It did not prevent the ſun or ſtars of the firſt magnitude from being ſeen, except in the lower part of the horizon. People could look at the ſun without being incommoded, and without uſing coloured or ſmoked glaſs. It appeared of different colours, according to the kind of rays which the difference in the denſity of the fog ſuffered to paſs. As the yellow

yellow and red, being the ſtrongeſt, were thoſe which pierced it ofteneſt, the ſun appeared like a ball on fire, or of a blood colour; which gave occaſion to many whimſical people, whoſe imaginations were heated, to ſee there, as in the clouds, the figures of men and animals. Very often the ſun, in the higher part of the atmoſphere, ſeemed pale and white by the abſence of ſeveral coloured rays; and he appeared red when he was lower, becauſe his rays then paſſed through a greater portion of the atmoſphere.

That it may not be imagined that this phenomenon is new in the world, I ſhall here give a ſhort account of thoſe obſerved formerly, analogous to it. But it will firſt be proper to ſay a few words reſpecting the cauſe of this extraordinary fog, which I am inclined to think came from Sicily and Calabria, where there were violent earthquakes. We know, by the accounts given, that the heavens in thoſe countries appeared cloudy after the great ſhocks, which may be readily believed when we conſider the immenſe exhalations that muſt have been diſperſed throughout the atmoſphere. In the month of June the ſouth-eaſt winds prevailed throughout all our country. Theſe winds at Venice are called *Foriani*, becauſe they firſt take place on this ſide of the gulph. It is very probable that theſe winds, traverſing that part of the atmoſphere, may have carried with them a large maſs of exhalations, which, being ſtopped by the chain of the Alps, diſperſed themſelves in Lombardy, and occupied even the Alps, which people, with aſtoniſhment, beheld red, or of different colours, according to the poſition of the ſun and of the obſerver. It does not appear that theſe exhalations aroſe from our territory, which was not ſeen to ſmoke, as is generally the caſe in the time of a fog; but it proceeded downwards, as if it had fallen from the atmoſphere. It was not ſeen to touch the earth, except when, by an optical illuſion, the nebulous ſtratum, by being lengthened, appeared united with the ſenſible horizon. It occaſioned no hurt, therefore, to the fruits of the earth; it is ſaid only that it blaſted the olives

and vines a little on the elevated grounds. If any suffered in the flat country, the cause may be ascribed to the rains which took place at the time when they were in bloom.

If this fog arose, as I have said, from exhalations disengaged at the time of earthquakes, it must have been dry, and must have contained abundance of earthy, fiery, mineral particles, with a great deal of inflammable air and electric fire. To these may be ascribed the frequent thunder which took place, especially towards the middle of the month. The thunder in general made dreadful ravage, burning houses and destroying men and animals. Letters from Hungary state, that, after several shocks of an earthquake, the city of Kremnitz was set on fire by lightning. The same fate was apprehended for Vicenza on the morning of the 26th, the repeated claps of thunder being so violent. Five or six houses were that day struck by the lightning, which occasioned considerable damage. The lightning fell also in about a dozen of places in the neighbourhood, particularly in the mountains.

I shall here subjoin a sort of chronicle of the periods when the sun was seen obscured by fogs; and I am persuaded that many other instances might be found in different authors. This notice will serve to banish every thing marvellous in regard to the fog of 1783; and to shew that nothing happens at present which has not happened formerly, and even attended with more disagreeable circumstances.

Epochs of the Sun being darkened, and of other similar Phenomena.

Years of Rome.

291 The sun darkened; a comet; fire in the heavens, (that is to say, an *Aurora borealis.*) *Julius Obsequens de Prodigiis.*

542 Sun redder than usual, being of a blood colour.

552 The disk of the sun appeared smaller.

554 In the kingdom of Naples, the weather being serene, the

Years of
Rome.

the ſun appeared of a blood colour, and the heavens as if on fire, (that is to ſay, an *Aurora borealis.*)

710 Among the prodigies obſerved during the year of Cæſar's death, is reckoned that of the ſun being darkened, and appearing red.

> Cùm caput obſcurâ nitidum ferrugine texit,
> Impiaque æternam timuerant ſæcula noctem.

Julius Obſequens relates at more length the prodigies which appeared; particularly torches ſeen in the heavens, and crowns ſurrounding the ſun, which for ſeveral months ſeemed to emit only a pale feeble light: People, therefore, could look at his diſk.

Years of the
Chriſtian æra.

264 A great earthquake, and darkneſs for ſeveral days.—*Friſtchio.*

396 At Conſtantinople there were ſuch extraordinary ſtorms that the earth ſhook, while the heavens ſeemed on fire. At that period people expected the end of the world.

790 And, according to others 798. For ſeventeen days the heavens afforded no light. This phenomenon was preceded by earthquakes in Candia and Sicily.—*Collect. Acad. de Lancil. Friſtchio.*

937 The heavens being ſerene, the ſun was darkened; and his rays, paſſing through the windows, ſeemed bloody.

1020 The moon appeared of the colour of blood, and flames fell from the heavens like a tower, (that is to ſay, a conſiderable thunderbolt, or globe of fire like a carcaſs or bomb full of grenades, ſuch as is ſaid to have been obſerved this year (1783) at the cathedral of Liege. If I am not miſtaken, Scheuchzer of Berne relates that he obſerved one). According to hiſtory there were other cataſtrophes: the ſea left its bed, and inundated

Years of the
Christian æra.

several places in the neighbourhood. The same thing happened during the hurricane of March 11th this year (1783).

1104 The sun and moon in disorder were eclipsed several times, (that is to say, were obscured :) there were seen falling stars, flaming fires, fiery meteors, lightnings, hail; typhons and hurricanes took place, which overturned churches and houses; destroyed men, cattle, and plants; and occasioned great devastation in the fields. This is exactly what happened in 1783.

1154 On the 1st of October, the sky, being serene, appeared all of a sudden quite darkened.

1206 People imagined that they saw in the heavens a human head; and the following year, in Germany, the sun seemed divided into three parts. Similar phenomena may easily deceive the imagination of men, which is generally confused during such events, as was observed in 1783.

1227 An earthquake and comet—the sun of the colour of blood.

1263 The sun obscured, without any clouds, in such a manner as not to give any light.

1383 An earthquake in Swisserland. A large circle afterwards around the sun for several days.

1549 There appeared in the afternoon, for three days in April, a globe all on fire. It is even said, that armies had been seen fighting in the heavens before, and two lions engaged. (These were the sportings of the light of an *Aurora borealis.*)

XX. Ob-

XIX. *Obſervations on Pumice Stone, and the Places where found. By Profeſſor* BECKMANN *.

PUMICE ſtone, *pumex, pierre-ponce, pomice,* is a porous, light, friable, rough kind of ſtone, which floats in water; neither ſtrikes fire with ſteel, nor effervesces with acids; contains little or no iron, but ſometimes more, ſometimes leſs magneſia; and, in a ſtrong heat, becomes fuſed to glaſs without the addition of any other ſubſtance. On account of its ſingular properties, an idea was entertained, even in the moſt ancient periods, that it muſt have originated in a different manner from other ſtones. As it was found in many parts floating on the ſea, the ancients conſidered it to be a kind of hardened ſea-ſcum; as from the ſame ſuperficial grounds the bones of the cuttle-fiſh, employed for many purpoſes like pumice ſtone, are called ſea-ſcum alſo. More attentive obſervers, however, perceived that it was indebted for its formation to the force of fire; eſpecially as it was found, for the moſt part, near volcanoes, and was actually thrown up by them.

It is now known with certainty, that real pumice ſtone is a volcanic production, both that thrown up by the ſea, and that found even in Germany, where there are no burning mountains. The latter kind is a proof that in theſe diſtricts there muſt formerly have been volcanoes; and the former, of volcanoes ſo near the ſea that their eruptions could reach it. No place, however, abounds more with this kind of ſtone than the Lipari iſlands, particularly Lipari and Vulcano, from which, ſince the earlieſt periods †, all Europe has been ſupplied with this ſtone, and chiefly by the

* A chemical examination of it may be found in Cartheuſer's *Mineralogical Eſſays*; Bergmann's *Opuſcula*, III. p. 197; and Achard's *Collection of Phyſical and Chemical Eſſays*, I. p. 58.

† Pumices laudatiſſimi ſunt in Æoliis inſulis. *Plin. Hiſt. Nat.* lib. xxxvi. cap. 21.

 Sicilians.

Sicilians. Of these islands we should have known little more than what has been told us in the fables of the poets, had they not been visited, in the year 1781, by Dolomieu, who published a mineralogical description of them *; for all other travellers who have given accounts of Sicily say nothing of them, partly because they followed the common routine, and wished to see only such objects as had been seen by others—and partly because these islands lie in a tempestuous sea, where to the danger of shipwreck is added that of being taken by the Barbary cruisers, who hover about in that neighbourhood during the whole summer. Travellers, however, who wish to see more than antiquities, and who are desirous to examine and describe more than things already known, may here expect a rich harvest, if they are accustomed to make observations in regard to natural history: for objects worthy of their notice cannot be wanting in islands where volcanoes of every kind exist, some continually burning, and some which, like Ætna and Vesuvius, are sometimes at rest, and sometimes in a state of violent eruption; where there are others totally extinct; and besides these, lava of all kinds, and in each degree of calcination, vitrification, and efflorescence †.

The Lipari islands, the *Insulæ Æoliæ* or *Vulcaniæ* of the ancients, lie between Italy and Sicily, but nearer to Sicily, from the coast of which the nearest is distant about thirty Italian miles. Dolomieu makes the number of them to be ten; others say there are eleven. The largest, which is the most fertile and best peopled, is called Lipari. It is eighteen Italian miles in circumference, and contains a

* See his Voyage to the Liparine islands. Compare also *Viaggi alle due Sicilie e in alcune parti dell' Apennino, dall' Abbate Laz. Spallanzani.* Pavia, 1793, 8vo. tom. ii.

† In regard to the precise situation of these islands, see Heman's map: *Sicilia, Sardinia, Corsica, Malta*, 1762, corrected by Zannoni. On the the three-sheet map published by Leller in 1770, under the title of *Mer Mediterranée*, the island of *Ustika* is entirely omitted.

small

ſmall town of the ſame name. According to Dolomieu, it is the inexhauſtible magazine from which all Europe obtains pumice ſtone; and it has whole mountains of that ſubſtance, in which large holes have been cut without any perceptible decreaſe being obſerved. Next to Lipari, and neareſt to Cape Melazzo in Sicily, lies Vulcano, nearly twelve Italian miles in circumference, and ſeparated from the former by a channel only one Italian mile in breadth. Its fire is never extinguiſhed; and it contains an inexhauſtible ſtore of pumice ſtone, which has a perfect reſemblance to that of Lipari. Some of it is collected for foreign trade; but this uninhabited iſland is viſited, at preſent, merely on account of its wood, which grows on the ſouth ſide of an ancient crater.

The pumice ſtone, however, of theſe iſlands, is very different in regard to ſolidity, hardneſs, and weight; and it may be diſtinguiſhed into four kinds, one of which only is employed in foreign commerce. The firſt is grey; has a cloſe grain, imperceptible interſtices and fibres; a conſiderable weight; great compactneſs; and ſomewhat of a vitreous fracture. This ſtone, which can be eaſily cut, is employed as corner-ſtones for buildings, and for all kinds of walls in general. The town of Lipari is almoſt entirely built of it.—The ſecond kind is alſo grey; but lighter, more porous, and has more perceptible fibres than the former, and does not float in water. It is uſed for arches; and on that account great quantities of it are carried to Sicily and Naples.—The third is light, porous, and full of fibres; it floats in water; has a ſilky appearance on the fracture; and is compact and of a hard grain, which renders it exceedingly proper for poliſhing marble and metals. This is the only kind employed in foreign trade.—The fourth kind is exceedingly white; of a very tender texture, and leſs compact than the others. It ſeems to have reached the utmoſt degree of extenſion, to which any ſubſtance can attain, for its parts to retain a connexion. This kind is fit for no pur-

poſe whatever. When it falls into the ſea, it floats often to a great diſtance; and it may be found ſometimes on the coaſt of Sicily and Calabria *. It is in general remarked, that the whiter pumice ſtone is, it is always the lighter †.

The moſt common uſe of this kind of ſtone is for poliſhing almoſt every kind of ſubſtance; and it is exceedingly proper for the purpoſe, as it is ſoft enough to be rubbed to a fine powder; and yet its fineſt particles remain ſo rough that they can attack and wear down the ſurface of bodies without making ſcratches. The powder of vitreous ſtones would alſo rub off particles by friction, but, on account of its acute edges, would leave ſcratches; and to pound it ſo fine as to prevent this inconvenience, would require much more trouble and time than the pumice ſtone; and even then, this fine powder of vitreous ſtones would ſuffer itſelf to paſs over the bodies to be poliſhed almoſt like argillaceous earth, without making any impreſſion upon them. The workmen, who employ pumice ſtone for this purpoſe, uſe it either pounded, ſifted and waſhed, or in whole pieces, as the hatmakers, curriers, and ſome workers in metal. The laſt muſt chooſe ſuch pieces as have fine pores, and are ſo large that they can aſſume the form proper for rubbing or ſcowering. On this account preference is given, in commerce, to that kind of pumice ſtone which does not conſiſt of too ſmall pieces. In general, it muſt be light, rough, friable, of a grey colour, and free from ſand or any other foreign

* Popowitſch, in his *Reſearches reſpecting the Sea*, p. 347, obſerves, that this pumice ſtone is caſt by the weſt wind on the Calabrian ſhores, and by the north wind on thoſe of Sicily and Greece. He was told there that it was a ſubſtance thrown up by the volcanoes of the Lipari iſlands. But it may be ſeen, by Dolomieu's account, that it never can be an article of commerce, as Popowitſch thinks.

† Cronſtedt ſays, in his *Mineralogy*, that the white pumice ſtone is produced from the black by its being bleached in the open air. But this is not the caſe: the white is of that colour when it is thrown up. See Olafsen's *Reiſe durch Iſland*, ii. p. 103. Linnæus, therefore, has been guilty of an error in his *Syſt. Nat.* iii, p. 181.

parts.

parts. When it is to be employed as teeth-powder, it muſt be pounded remarkably fine; and even then it will attack the teeth too ſtrongly.

In countries where pumice ſtone can be procured at a cheaper rate than among us, it is pounded and mixed with the mortar uſed in building. This is done in Italy *; and the caſe muſt have been the ſame in former times, as pieces of it are frequently to be obſerved in the mortar of ancient walls. It has this binding property in common with terras, pozzolana, and other volcanic productions. From this circumſtance we might be induced to conjecture, that the ancients mixed fine *terra ſigillaris* with pumice ſtone coarſely pounded, and formed it into moulded maſſes, which they dried in the ſun, in order to make thoſe bricks for building, which, as Strabo, Pliny, Antigonus Caryſtius, Vitruvius, and others †, tell us, with ſome degree of wonder, ſwam in the water; and that, on account of their lightneſs, they were peculiarly well adapted for many uſeful purpoſes. They expreſsly ſay, that the ancients uſed, in making them, the mineral employed for cleaning ſilver-plate, which we may conſider to have been pumice ſtone; though many other kinds of earths are fit for the ſame purpoſe. This conjecture has given riſe, in modern times, to experiments which have not yet been attended with complete ſucceſs. It will be difficult, indeed, to obtain bricks ſo light by mixing clay with finely pounded pumice ſtone, as it will then form a body too compact and heavy. From a paſſage in the Travels of Peter Della Valle ‡ one might be induced to conjecture, that the art of making ſwimming bricks was known at Ormus, an iſland in the Perſian Gulph, unleſs he meant perhaps to ſay that pumice ſtone was employed there for building as in

* Labat's *Reiſe durch Italien*, iv. p. 16.

† The teſtimonies of the ancients on this ſubject I have given in a note to the *Hiſtoriæ Mirab.* of Antigonus Caryſtius, cap. clxxxvii. p. 228.

‡ Della Valle's Travels. Geneva, 1674. fol. 3. p. 239.

Sicily;

Sicily; but in Sicily the heavy kind of pumice ftone, which does not fwim, is employed for that purpofe. It is worthy of remark, that among the fo-called Etrufcan and other earthen ware, as well as among thofe which were formerly brought from Japan and China oftener than at prefent, there were veffels much lighter and thinner than any that can be manufactured in Europe. It is not improbable that Fabbroni may have been fo fortunate as to difcover this preparation: at any rate, he not long ago laid before the Economical Society of Florence, for examination, a kind of brick, the fpecific gravity of which was not greater than that of the lighteft wood *.

Moft authors, who give an account of pumice-ftone, fpeak of it as if it were to be found in the neighbourhood of all burning mountains. This, however, is falfe; for it is not found among the productions of all volcanoes, but only near thofe, as the mineralogifts affert, the fire of which has arifen in fuch ftrata as have intermixed with them a great deal of feld fpar. It is found nowhere in greater abundance than in the Liparine iflands, as already faid, though large quantities of it are found in Iceland; whereas it is very feldom feen near Vefuvius, and never in the neighbourhood of Ætna. The ancients, however, fpeak of Ætnean pumice-

* After I had written this article, I found in Gren's *New Phyfical Journal*, Vol. II. part 2. p. 129, a paper tranflated from the Italian of Fabbroni, by which it appears that he made his brick of a kind of earth dug up near Santa Fiora, in the territories of Sienna, which neither effervefces with acids nor is fufible in the fire, and which, according to his examination, confifts of filiceous earth, magnefian earth, and aluminous earth, in the proportions of 0·55, 0·15, and 0·12. This earth, therefore, feems to confift of the fame component parts, and almoft in the fame proportions as the fo-called fea-froth. According to the prevailing mode of changing old names and making new ones, Fabbroni calls the above earth *Farina foffilis*, under which is underftood, at prefent, an earth arifing from effloresced gypfum.

[For Fabbroni's method of making floating bricks, fee *The Philofophical Magazine*, Vol. II. p. 180. Edit.]

ftone;

ſtone; for example, Cornelius Severus, the author of a poetical deſcription of that mountain. Theophraſtus ſpeaks alſo of the pumice-ſtone of Ætna, which he deſcribes as black and heavy *. Under this head we may place the *Catinenſis pumex* of Juvenal †, though this phraſe will admit of another explanation; and perhaps the poet meant only to indulge in a little occaſional raillery againſt the celebrated voluptuaries of Catina or Catana. I well know that we cannot expect from poets, in general, the accuracy which muſt be obſerved by naturaliſts; but thoſe who conſider the paſſage as admitting of no doubt, may ſupport it by the teſtimony of Gioeni ‡, who found pumice-ſtone, perfectly like that of Lipari, in the neighbourhood of Ætna, during the eruption of 1787; but he adds, that nothing of the kind had ever been found near Ætna before.

XX. *Eighth Communication from* Dr. THORNTON, *Phyſician to the General Diſpenſary, relative to Pneumatic Medicine.*

CASE OF PARALYSIS CURED BY THE INHALATION OF VITAL AIR.

MR. HUITSON, who diſſects for Mr. Cruickſhank and Mr. Willſon, eminent teachers in the ſchool of the late Dr. Hunter, had a paralytic affection of the right hand, which deprived him of its motion, and it felt to the other hand al-

* See the faulty German tranſlation of his work on ſtones, § 40. p. 120. I ſhall here occaſionally obſerve, for the ſake of thoſe who are fond of comparing the accounts of the ancients and moderns, that a kind of *traſs* was employed for mill-ſtones in the time of Theophraſtus and Strabo. [illegible] Strabo, Lib. VI. p. 413. The ancients were acquainted alſo with the uſe of that kind called by Cronſtedt the Rheniſh mill-ſtone; a good deſcription of which has been given by Collini in *Journal d'un Voyage*, Manheim 1776. 8. p. 301. Compare alſo my *Phyſikaliſch-Oekon. Biblioth.* Vol. VII. p. 455 and 519.

† Sat. VIII. 16.

‡ See *Von Salis' Collections towards a Natural Hiſtory of the Kingdom of the Two Sicilies*, 1790. 8. I. p. 172.

ways

ways remarkably cold. The paralyfis feemed chiefly feated in the mufcle of the thumb. I advifed him the trial of electricity; and we obferved, as well as thofe who accompanied him, that the electric fpark did not fly with a crackling noife to the paralytic mufcles. Trying a piece of dead meat we found the fame phenomenon. We then had recourfe to inhalation of vital air mixed with atmofpheric, and he inhaled from fix to eight quarts vital air. The mufcle, now receiving oxygenated blood, afterwards caught the electric fpark very readily, and a genial warmth was diffufed throughout the paralytic hand. This was not a folitary obfervation, but conftant; and it feems to me very forcibly to prove the animating principle derived from the oxygen of the air to the mufcular fibre; a principle not, as reprefented by Mayow, the moft fubtle, fpiritual, and ætherial, but one that can be made obvious to our fenfes in the form of air, adhering to the calces of metals, and capable now of being conceived even by the moft grofs underftandings.

The patient, I am happy to add, by this *combination* of external and internal ftimulants, was completely reftored, and has continued many months perfectly well.

As the cafe is fhort, I will fay a few words on the combination of remedies. The Faculty, and others, are always crying out for the trials of the airs *alone*, and forget that in their own practice they employ a variety of means. Thus, although exercife is recommended, is the ftomach neglected to be braced and ftimulated?

The following cafe from John Hunter* is very illuftrative of this pofition:

" A lady, of what is called a nervous conftitution, arifing in fome degree from an irritable ftomach, often troubled with flatulencies, and what are called nervous head-achs, with pale urine at thofe times, uncomfortable feelings and often finkings, had a tumor removed from the breaft, and likewife near the arm-pit: nothing appeared uncommon for a few

* Vide *Hunter on the Blood*, p. 412.

days, when very conſiderable diſorders came on. She was attacked with a ſhivering, or cold fit, attended with the feel of dying, and followed with cold ſweats. It being ſuppoſed ſhe was dying, brandy was thrown in, which ſoon brought on a warmth, and ſhe was relieved. The fits came on frequently for ſeveral days, which were alſo relieved by brandy; and ſhe took, in one of the moſt violent, half a pint of brandy. While under theſe affections, ſhe had the bark as a ſtrengthener; the muſk occaſionally, as a ſedative, in pretty large quantities; camphorated jalap frequently, as an antiſpaſmodic; and, towards the laſt, ſhe took the valerian in large quantities: but whatever effects theſe might have in leſſening the diſeaſe, on the whole *they were certainly not equal to it without the brandy*."

John Hunter judiciouſly adds: "A queſtion naturally occurs: Would *the brandy alone*, if it had been continued as a medicine, have cured her without the aid of the other medicines? The other medicines, I think, certainly could not have done it; nor do I believe that the brandy could have been continued in ſuch quantity as to have prevented their returns: if ſo, then *the two modes were happily united*, the one gradually to prevent, the other to remove immediately the fits when they came on."

INTELLIGENCE,

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

AMERICAN PHILOSOPHICAL SOCIETY.

THIS Society has recently publiſhed the following circular letter:

"The American Philoſophical Society have always conſidered

fidered the antiquity, changes, and the prefent ftate of their own country as primary objects of their refearch; and, with a view to facilitate fuch difcoveries, a permanent committee has been eftablifhed, among whofe duties the following have been recommended as requiring particular attention:

"1. To procure one or more entire fkeletons of the Mammoth, fo called, and of fuch other unknown animals as either have been, or hereafter may be difcovered in America.

"2. To obtain accurate plans, drawings, and defcriptions of whatever is interefting (where the originals cannot be had); and efpecially of ancient fortifications, tumuli, and other Indian works of art: afcertaining the materials compofing them, their contents, the purpofes for which they were probably defigned, &c.

"3. To invite refearches into the natural hiftory of the earth, the changes it has undergone as to mountains, lakes, rivers, prairies, &c.

"4. To inquire into the cuftoms, manners, languages, and character of the Indian nations ancient and modern, and their migrations.

"The importance of thefe objects will be acknowledged by every lover of fcience, and, we truft, fufficiently apologife for thus troubling you; for without the aid of gentlemen who have tafte and opportunity for fuch refearches, our means would be very confined. We therefore folicit your communications, now or in future, on thefe fubjects; which will be at all times thankfully received, and duly noticed in the publications of the Society.

"As to the firft object, the committee fuggeft, to gentlemen who may be in the way of inquiries of that kind, that the Great Bone Lick on the Ohio, and other places where there may be mineral falt, are the moft eligible fpots for the purpofe, becaufe animals are known to refort to fuch places.

"With refpect to the fecond head, the committee are defirous that cuts in various directions may be made into many of the tumuli, to afcertain their contents, while the diameter

of

of the largeſt tree growing thereon, the number of its annulars, and the ſpecies of the tree, may tend to give ſome idea of their antiquity. If the works ſhould be found to be of maſonry; the length, breadth, and height of the walls ought to be carefully meaſured, the form and nature of the ſtones deſcribed, and ſpecimens of both the cement and ſtones ſent to the committee.

"The beſt methods of obtaining information on the other ſubjects will naturally ſuggeſt themſelves to you, and we rely on a diſpoſition favourable to our wiſhes.

"The Committee conſiſt of the following gentlemen, *viz.*

Thomas Jefferſon, Preſident of the American Philoſophical Society, at Monticello in Virginia.

James Wilkinſon, Commander of the Army, at Head Quarters.

George Turner, of the Weſtern Territory, near Cincinnati.

Dr. Caſpar Wiſtar, Vice-Preſ. of the A. P. S.
Dr. Adam Seybert, Secretary of ditto.
C. W. Peale, and
Jon. Williams, — in Philadelphia.

"Your communications may be addreſſed to any one of the Committee; but the articles you may think proper to furniſh, ſhould be ſent to this place.

In behalf of the Committee, I am, reſpectfully,
Sir, your obedient ſervant,
J. WILLIAMS, Chairman."

At the meeting of this Society, January 10, 1799, among other donations and communications, the following were announced as having been received:

A communication from Mr. Andrew Ellicot, determining the latitude and longitude of the town of Natchez—A letter from Dr. Prieſtley on the decompoſition of water—Three barrels, containing the bones of non-deſcript animals, and two meteorological journals kept at Detroit and on a voyage to Michilimacanac on the Lakes, by Gen. Wilkinſon—A ſpecimen of mica from New Hampſhire—Experiments and obſerva-

obſervations on the atmoſphere and marſhes, by Dr. Seybert—And a paper concerning the pernicious effects of the *Equizetum hyemale*, or rough horſe-tail, when eaten by horſes; by Mr. Barton.

MISCELLANEOUS.

AMERICAN ENTOMOLOGY.

With pleaſure we announce to naturaliſts Mr. Baker's collection of American inſects. In his muſeum at New-York may be ſeen about three thouſand ſpecies, principally arranged according to the Linnæan ſyſtem. They were collected chiefly by Mr. Jotham Fenton, who has been nearly ſix years engaged in entomological purſuits. The ſpecies of this collection were moſtly caught in the neighbourhood of the cities of New-York and New-Haven.

FIRE-BALL.

A very remarkable phenomenon of this kind was ſeen in the county of Kent, and the neighbourhood, on Sunday the 22d September, at about 35 minutes paſt eight in the evening. It came from the ſouth-weſt, and paſſed in a ſouth-eaſt direction till it ſunk in the horizon. It ſeemed to be nearly of the ſize of the moon, but of an oval form, or rather in the form of an ox's bladder, the thickeſt end going foremoſt. The ſky, which was dark and ſtormy, was illuminated during its paſſage more brightly than by the full moon. Its colour was a vivid white, inclining a little to yellow; and it ſeemed as if followed by a few ſmaller globules, or rather large ſparks of a red colour, which kept at the ſame diſtance from its body during the whole time that it was viſible, which was for ſeveral ſeconds.

ASTRONOMY.

A comet is now viſible in our hemiſphere. It was firſt ſeen on the 6th inſt. near the lower ſide of the quadrangle of *Urſa Major*, from which it has been moving about 3° in 24 hours, following the direction of the tail, and through one ſhoulder of Bootes.

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END OF THE FOURTH VOLUME.

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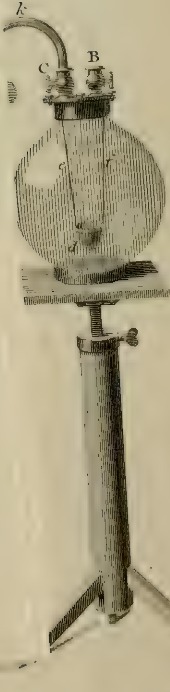
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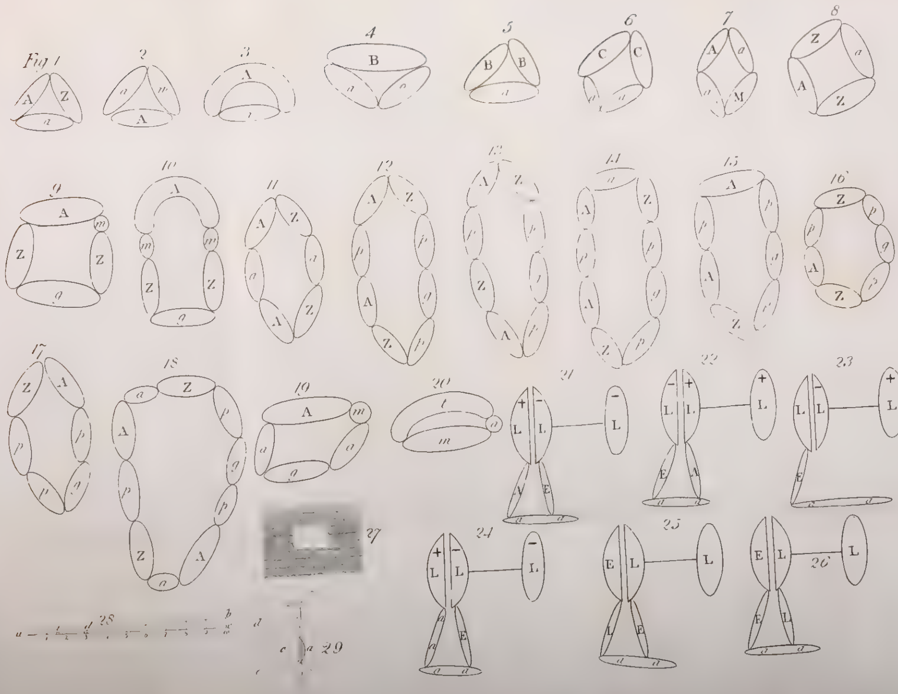

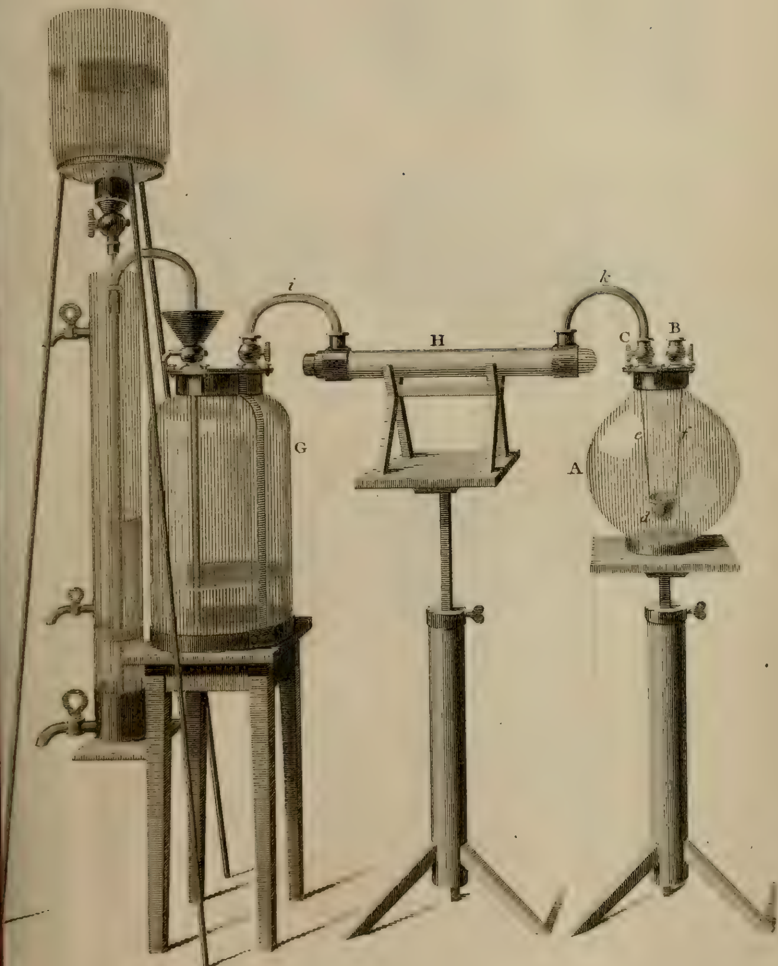
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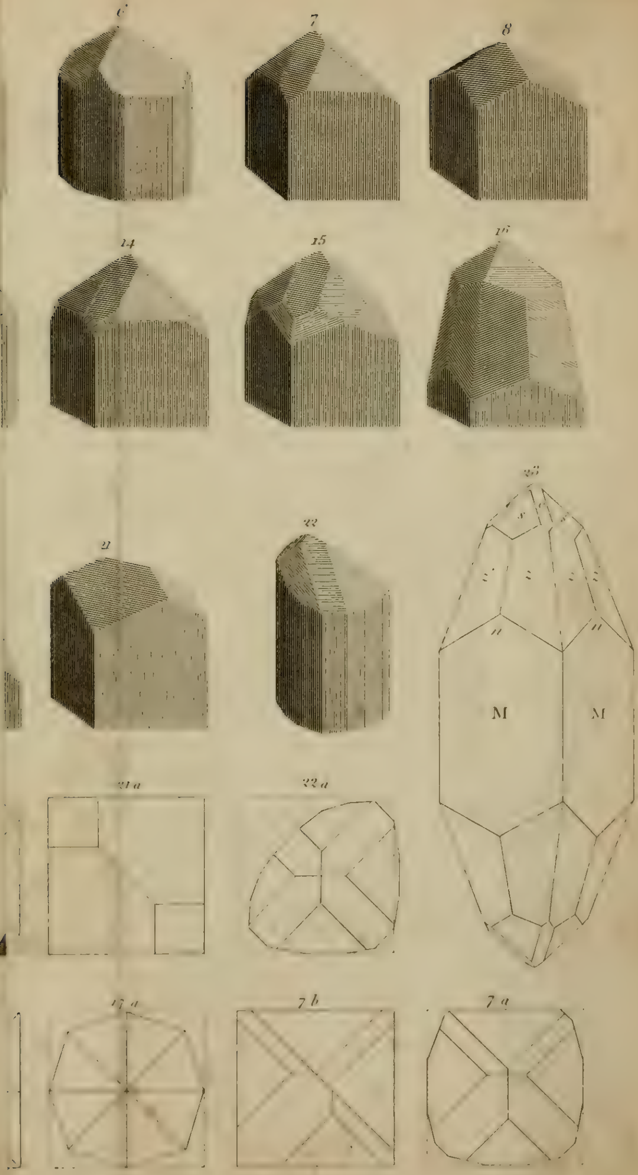

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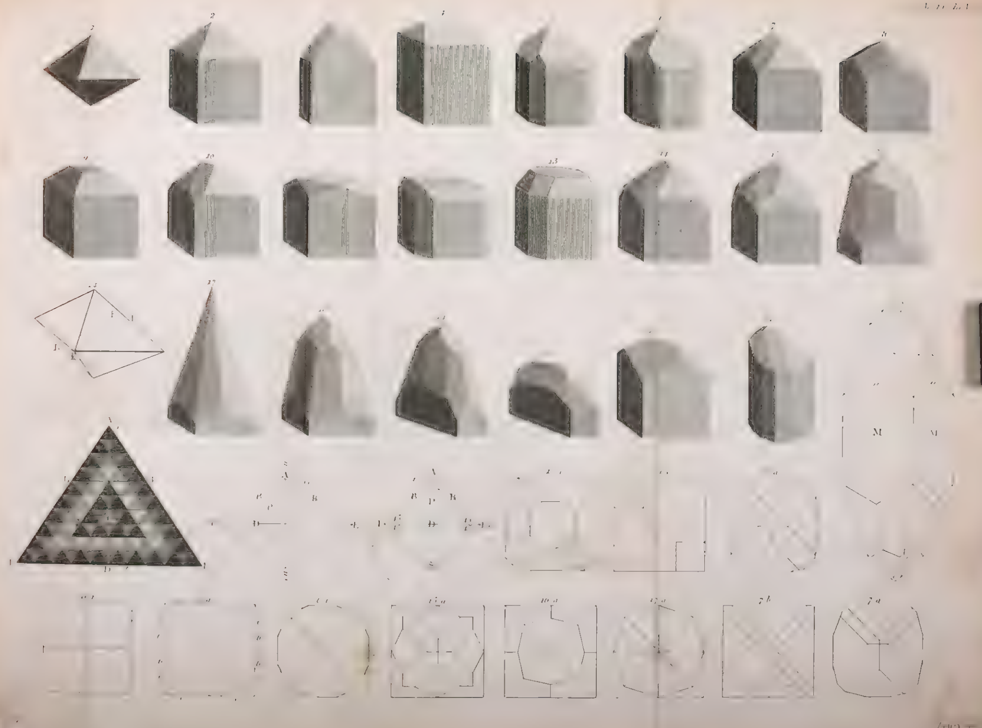

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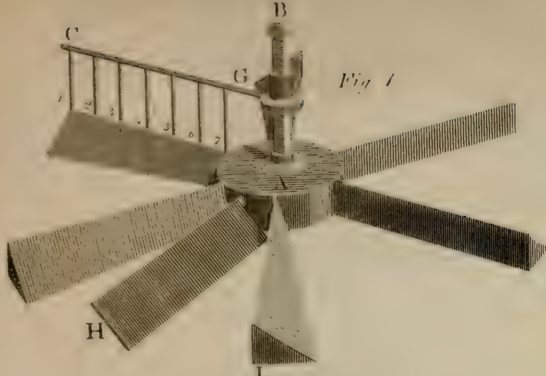

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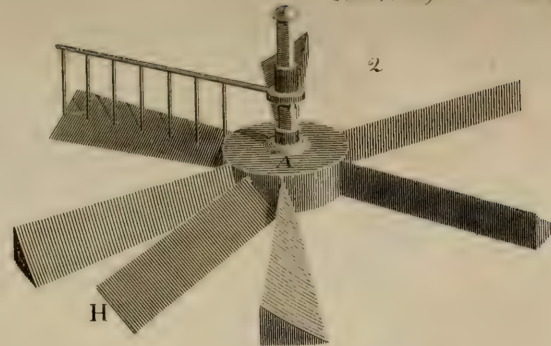

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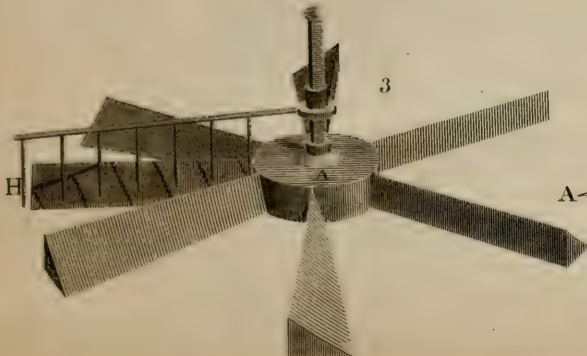

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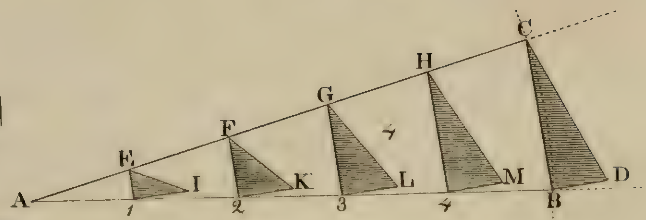

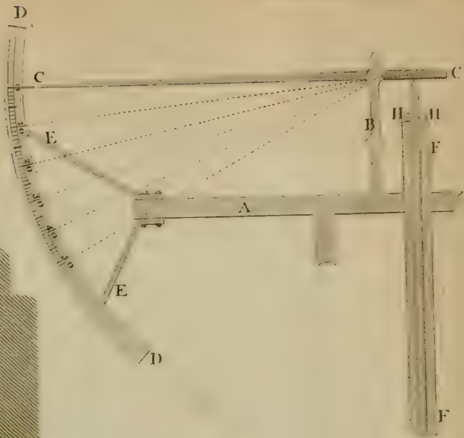

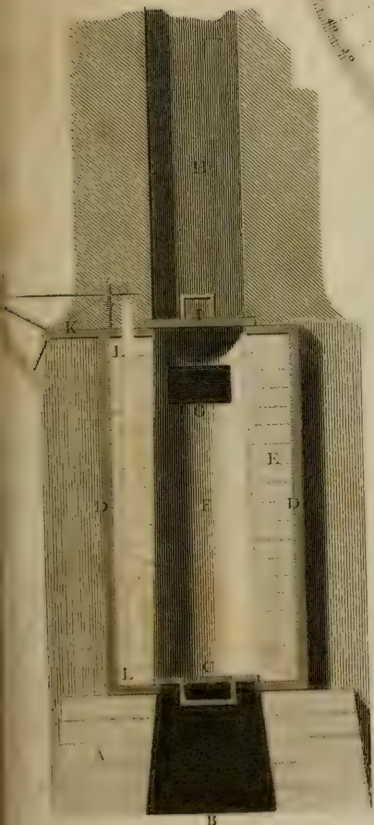

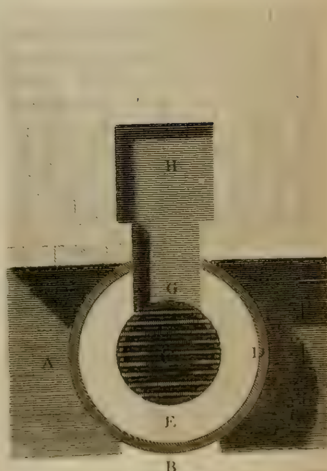

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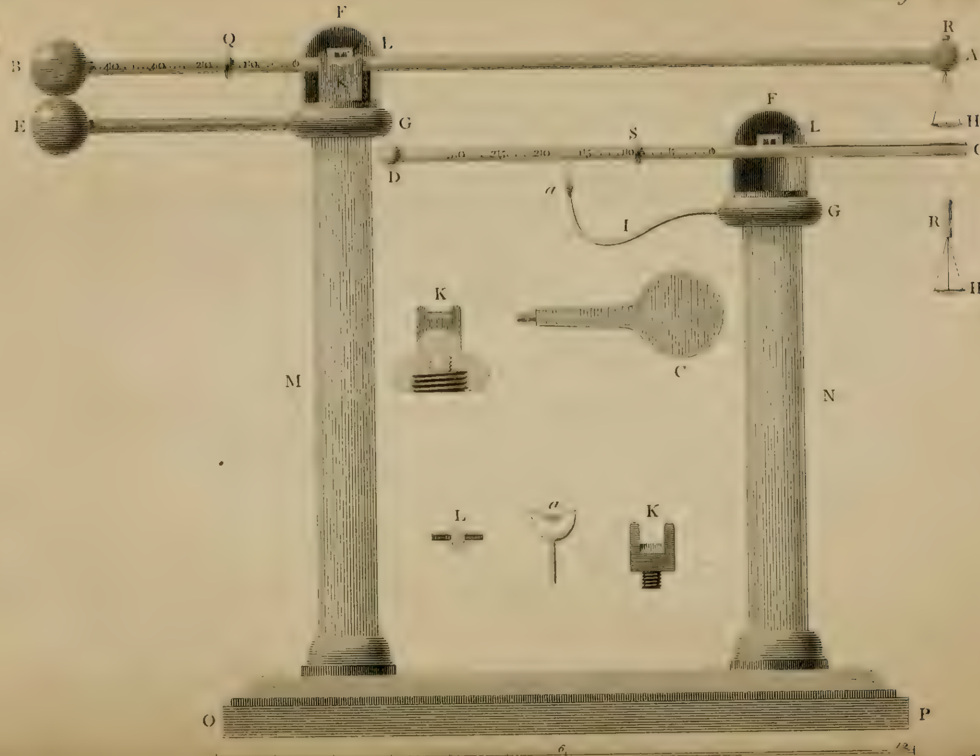

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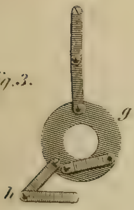

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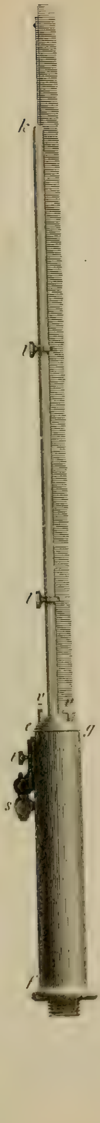

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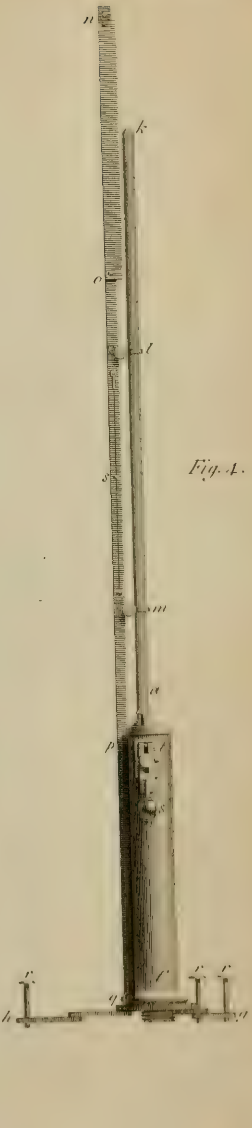

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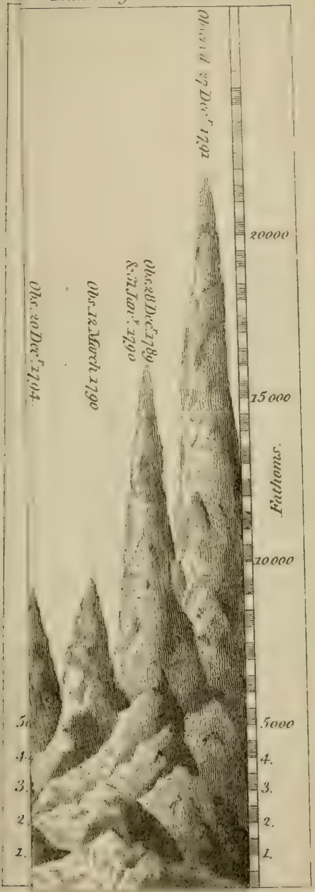

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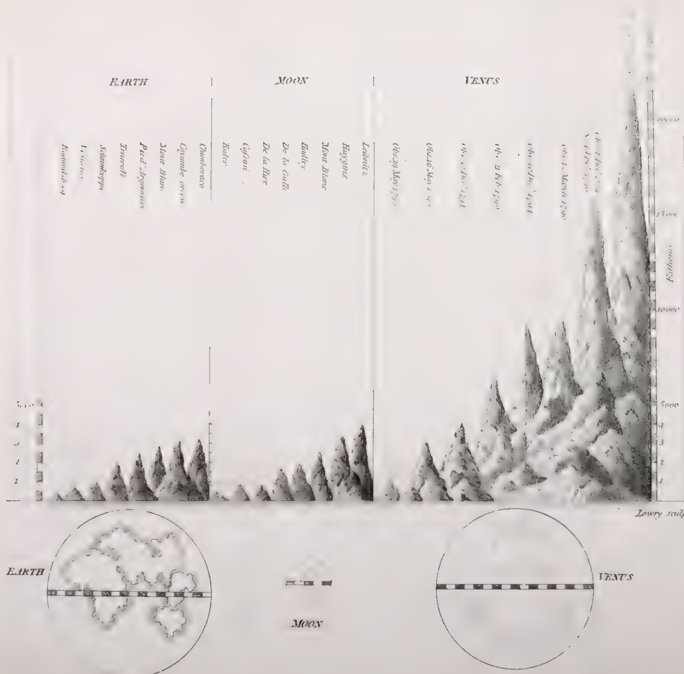
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Lowry sculp

Fig. 2.


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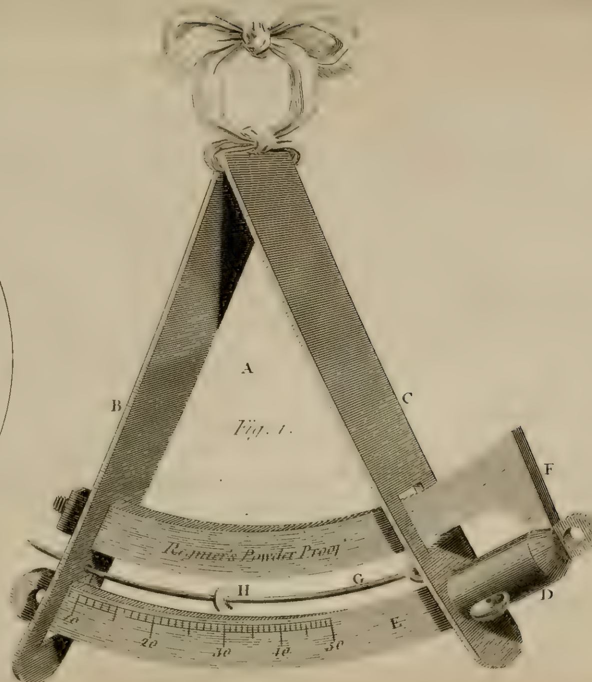
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H
Regnier's Powder Proof
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Fig. 1.

by Mr. Robert Salmon, of Woburn, Bedfordshire, for which a Bounty was voted to him by the Society for the Encouragement of Arts, &c.—The new Machine invented and employed by the late Mr. Custance to make his unrivalled Vegetable Cuttings for the Microscope; drawn and engraved from the Machine itself, now in the possession of Dr. Thornton; a Plate to explain the Method of forming Figures with Sand on Vibrating Surfaces, according to Dr. Chladni's Theory—The Furnace employed by the French Chemists in their Examination of C. Clouet's Process for the immediate Conversion of Iron into Cast Steel by means of Carbonat of Lime; and the New Steel-Yard invented by C. Paul of Geneva.

Number XIII. is illustrated with a Plate of Figures to explain Volta's Theory of Galvanism—Apparatus employed by Dr. Van Marum for the Combustion of Phosphorus in Oxygen Gas.

Number XIV. is illustrated with a 4to Plate relative to the Structure of the Crystals of Oxyde of Tin—and a Plate illustrating the best Construction of the Vanes of Windmills as far as concerns the Angle of Weather.

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*** Dr. Whyte's Favour came to hand too late for insertion in the present Number, but shall certainly appear in the next.

ENGRAVINGS.

Machine for drawing Bolts in and out of Ships—Cit. Guyton's Eudiometer; the improved Machine for Cutting Chaff, invented by Mr. Robert Salmon, of Woburn, Bedfordshire, for which a Bounty was voted to him by the Society for the Encouragement of Arts, &c.—The new Machine invented and employed by the late Mr. Custance to make his unrivalled Vegetable Cuttings for the Microscope; drawn and engraved from the Machine itself, now in the possession of Dr. Thornton; a Plate to explain the Method of forming Figures with Sand on Vibrating Surfaces, according to Dr. Chladni's Theory—The Furnace employed by the French Chemists in their Examination of C. Clouet's Process for the immediate Conversion of Iron into Cast Steel by means of Carbonat of Lime; and the New Steel-Yard invented by C. Paul of Geneva.

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Number XV. is illustrated with a Plate of Mr. Mushet's Pyrometer for ascertaining the Heat of an Assay-furnace—Von Hauch's New Discharging Electrometer, laid before the Royal Society of Copenhagen—and, Humbolt's Portable Barometer for Travellers, &c.

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